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SPECIAL FEATURES OF THE OUTBREAKS OF THE SHIELD BUG EURYGASTER INTERGRICEPS PUT. (HETEROPTERA, PENTATOMIDAE) IN THE CENTRAL CHERNOZEM ZONE

A. V. Zhukovskii

Two outbreaks of the injurious shield bug have been observed in the Central Chernozem (Black Earth) Zone during the last 20 years. The first occurred in the period 1938-1941 (Ostapets, 1941; Zhukovskii and Ostapets, 1944; Zhukovskii, 1946), and the second 12 years later, in the period 1953-1957. In both cases the occurrence of the shield bug was confined to the southern (steppe) regions; the northern limit of its occurrence practically coincided with the long-established natural boundary between steppe and forest steppe: in Voronezh region this boundary follows a line through Novokhopersk, Buturlinovka, Ostrogozhsk, and then continues into Belgorod region through the Nikitovka, Volokonovka and Shebekino districts. The injurious shield bug is not an abundant pest in the forest steppe area, i.e., the northern half of the Voronezh and Belgorod regions, and all districts of the Kursk, Orel, Lipetsk and Tambov regions. It multiplies most rapidly and causes considerable damage in the most southern districts of Voronezh region – Mikhailovka, Kantemirovka, Boguchar, Novaya Kalitva and neighboring districts.

In the size of the territory affected, and in the nature of the multiplication the above two outbreaks were similar. During the 1938-1941 outbreak the greatest rate of reproduction was reached in 1940. In many regions, particularly in the most southern part of Voronezh region (Boguchar, Kantemirovka and other districts), the large numbers of bugs of the new generation caused a total loss of the winter wheat sowings for that year. This led to a food crisis for the shield bug; cases of mass mortality were observed among larvae and young winged bugs on the destroyed wheat sowings (OGPU Collective Farm in Kalach district), and the bugs migrating into the woods for wintering had a low fat content. As a result of the weakened condition of the bugs they were severely attacked by fungal and bacterial diseases during hibernation, and in consequence the bulk of the bugs perished in the woods. In these conditions the shield bug suffered a sharp depression in 1941 in most regions affected by the outbreak; only in the small northern group of steppe districts, where the shield-bug population in 1940 was not so high, and where they did not experience a food crisis, were there observed centers of population on some spring wheat sowings (Fig. 1).

The development of the new generation of bugs in 1941 was greatly delayed owing to unfavorable weather conditions; the adults did not begin to appear till late (July 17); and the great majority of larvae did not complete their development and died off before the time for departure of the bugs into the woods. An inspection of the wintering sites in autumn 1941 showed that the bug was present in very small numbers and in the following years (up to 1953) it experienced a long period of depression in all the regions of its occurrence in the area of the Central Chernozem Zone.

Figure 2 illustrates the fluctuations of the shield-bug population in the southern districts of Voronezh region during 1951-1957. The figure shows the average number of bugs per 1 m^2 in spring (after hibernation) over a period of 7 years in one wood in Mikhailovka district. As regards development of the shield bug this district was typical of the whole group of southern districts of its occurrence in the Central Chernozem Zone. In these districts the shield-bug population rose steeply from 1951 and reached its peak in spring 1956 (an average of 119.3 viable individuals per 1 m^2). In autumn 1956 the number of bugs which had migrated for hibernation was very much

Fig. 1. Districts affected by shield-bug outbreak in 1940-1941.

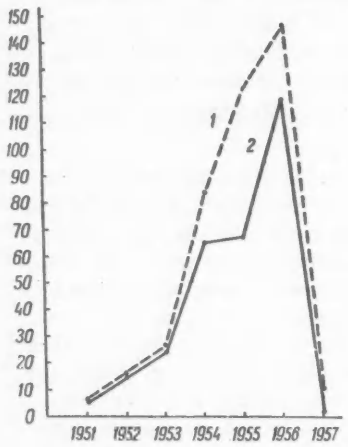

Fig. 2. Fluctuations of shield-bug population in a wood after hibernation (Mikhailovka district of Voronezh region). Bugs per 1 m^2: 1) live and dead; 2) live.

less than in the preceding years (down to 10 per 1 m^2), and in spring 1957, i.e., after hibernation, the average number had fallen to 1.4 per 1 m^2.

As we can see from the data given in Fig. 2, the number of shield bugs in the woods in spring 1957 was only a quarter of that in 1951, and the shield bug as was to be expected, suffered a pronounced depression.

The reason for this sharp decline in the shield-bug population in the southern districts of the Central Chernozem Zone was the unfavorable weather conditions for its development in 1956. In these districts there was a widespread loss of winter wheat owing to frost in winter 1955/56: The winter wheat was almost a total loss in all the collective farms and in spring the fields were resown with spring crops, but the rye was very thin. There was practically no spring wheat sown in 1956; there were only small areas (15-20 ha) of this crop in a few of the collective farms. Under these conditions the shield bug experienced a shortage of food plants and was obliged in spring 1956 to settle on crops unusual for it — oats, barley, and even maize, on which the development of a new generation cannot take place. The main mass of shield bugs was concentrated (in patches) on the surviving winter wheat plants and on the limited spring wheat sowings.

During the egg-laying period the bugs left the maize and migrated onto the spring and winter wheat, with the result that the numbers there became still higher. As a final result the spring wheat was severely damaged and perished; it was consequently plowed under and this completely exterminated the new generation of bugs developing on it. The high concentration of bugs on the scattered winter wheat plants which had survived the frost resulted in the winter wheat perishing before earing, and as result a new generation of bugs did not develop there either.

The only crops where the shield bug could develop in 1956 were oats and barley, but the growth of the larvae on them, and also the accumulation of fat in the winged bugs, takes place very slowly. According to

Fig. 3. Districts affected by shield-bug outbreak in 1956-1957.

TABLE 1

Fat Accumulation in Shield Bugs from Oats and Barley in 1956

Crop	Date of analysis	Fat content of females (in %)
Barley	11 VII	13.8
	17 VII	18.9
	24 VII	26.5
	28 VII	29.5
Oats	24 VII	22.8
	28 VII	24.7
	2 VIII	29.5

observations made in Mikhailovka district the period spent in the fields by adult bugs of the new generation after the onset of the winged stage (June 29) to the start of migration into the woods (July 27) was very long – about 30 days. Table 1 gives the results of determining the fat content of winged bugs taken from oats and barley at different times.

The ripening of the oats and barley in 1956 was delayed, and the harvest of the crops was late – late July-early August. Nevertheless, by the time of harvesting about 50% of the shield bugs were still in the fourth and fifth larval instars; they perished without reaching the adult stage. The majority of the winged bugs, owing to their low fat content, also died off before they could go to their wintering sites. Woods in the southern districts of Voronezh and Belgorod regions were inspected* in late September - early October 1956 and in every case the shield bugs were found in small numbers and in a weakened (as regards fat content) condition (Table 2).

The weakened condition of the bugs was the reason for the high mortality among them during the wintering period. In Mikhailovka district, for instance, the percentage of dead bugs in the woods in spring 1957 reached 93. The number of surviving bugs, as already mentioned, was reduced to an average of 1.4 per 1 m^2, i.e., it was considerably lower than in 1951. The same situation was observed in all the southern districts of Voronezh and Belgorod regions.

Such were the main causes leading up to the changeover from outbreak to depression of the shield bug in the southern districts of the Central Chernozem Zone in 1957.

The course of development of the shield bug in the more northerly districts of its occurrence – Kalach, Vorob'ev, Buturlinovka, etc. – was somewhat different (Fig. 3). In these districts, just as in the southern ones, the spring wheat was a total loss, but greater areas of winter wheat remained (although there were areas completely

*This survey was carried out by scientific workers T. N. Petrova, V. D. Galanova and A. G. Labuzina.

TABLE 2

Numbers and Condition of Shield Bugs Which Migrated for Hibernation in the Southern Districts of the Central Chernozem Zone in Autumn 1956

District	Date of investigation	Average number of bugs per 1 m^2	Percentage fat content of females
Mikhailovka	16—20 X	5.9	28.3
Nov. Kalitva	27—30 IX	20.1	26.7
Rossosh'	3—12 X	11.8	28.2
Valuiki	17 X	0.9	—
Urazovo	18 X	1.3	25.7

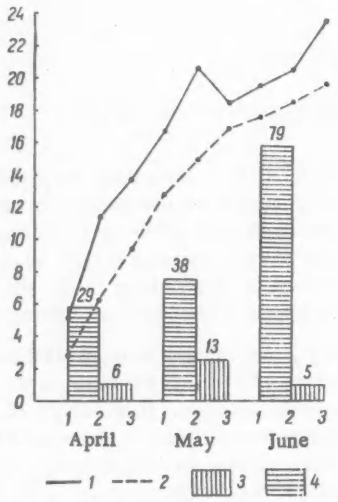

Fig. 4. Temperature and precipitation (Kalach, Voronezh region). Mean ten-day temperature: 1) 1956; 2) mean of many years. Monthly precipitation: 3) 1957; 4) over many years.

destroyed or severely thinned), and on these the shield bugs developed. The numbers of the new generation, particularly on the thinned crops, were very high; in some collective farms in the Kalach district the numbers of larvae and winged bugs on winter wheat prior to harvesting reached 600 per 1 m^2 ("Twentieth Anniversary of October" Collective Farm). The great majority of larvae completed their development — by harvest time (July 24) more than 80% had become winged bugs. The grain harvested from the winter wheat fields on which the shield bugs were concentrated was very severely damaged (its absolute weight was 14). Under such conditions the bugs could not lay up a sufficient store of fat. The percentage fat content of females taken from winter wheat at the time when the bugs started to migrate into the woods, varied on the average from 26.0 to 30.8% ("Twentieth Anniversary of October" and "Chapaev" Collective Farms in Kalach district). Some of the bugs perished in the fields before migration to the woods; bugs with better-developed fat bodies migrated into the woods and in places formed a considerable wintering stock for 1957. For instance, from a survey made by scientific worker T. A. Sokolova in late September 1956, the average number of shield bugs per 1 m^2 in the woods of Kalach district was 253, and in some spots reached 822. The percentage fat content of the wintering females was 34.8.

During the wintering period the bugs died off in large numbers (the mortality on the average was 83.4%); the numbers of viable bugs found in spring 1957 in the same woods varied from 9.2 to 23.2 individuals per 1 m^2. This number was sufficient to form a center for recolonization of crops by the shield bug. Owing to the absence of spring wheat crops, the development of the shield bug in 1957 took place only on the winter wheat. The numbers of the bug on certain areas of winter wheat in spring reached 3-5 per 1 m^2, and the number of egg batches 6 per 1 m^2.

It should be noted that many farms simultaneously carried out DDT dusting of the crops during the period of hatching of the larvae in 1957, and this measure was very effective. On areas treated with DDT only small numbers of larvae appeared even in fields where considerable egg laying had been observed. In correspondence with this the damage to grain was slight in comparison with crops which had not been dusted (Table 3).

The growing period in 1957 was marked by unusually high temperature and very low precipitation (Fig. 4). In June, for instance, the maximum air temperature over a period of 11 days was more than 30°, and the precipitation was only 5 mm (normal — 79 mm). The hot dry weather accelerated the development and ripening of the cereals. The winter wheat harvest began at the end of June (June 28), i.e., 15-20 days earlier than usual, and was completed in a very short time (first ten days of July). The two-stage harvesting in 1957 began at the same time as the combine harvesting, i.e., when the grain was almost fully ripe.

The development of the new generation of shield bugs in these weather conditions was accelerated, but it still lagged behind the development and ripening of the cereals. By the time the grain was fully ripe more than half of the shield bugs were still in the third, fourth or fifth larval instars (Table 4).

TABLE 3

Development of New Generation of Shield Bug and Damage to Winter Wheat Grain in 1957 (Kalach District)

Collective Farms	Per 1 m²		Percentage damage to grain	Notes
	egg batches	new-generation bugs		
"Chapaev"	3.3	2.7	3.9	Dusted with DDT against larvae
"Legacy of Il'ich"	3.0	2.7	1.8	The same
"Zhdanov"	6.3	6.0	1.7	" "
"Legacy of Il'ich"	5.3	6.3	2.0	" "
" "	—	—	32.1	Not dusted
"Thaelmann"	—	—	24.0	" "

TABLE 4

Age Composition of Shield-Bug Population at Time of Full Ripening of Grain in 1957 (Kalach District)

Winter wheat variety	Full ripening of grain	Proportions (in %)			
		Larval instars			Winged bugs
		III	IV	V	
Odesskaya 3	28 VI	4.7	14.4	38.1	42.8

TABLE 5

Fat Content (in %) of Winged Females on Winter Wheat in 1957

28 VI	2 VII	5 VII	7 VII	9 VII	11 VII
16.0—24.0	23.1	20.5—31.5	15.6	21.7	19.6

TABLE 6

Numbers and Condition of Shield Bugs Which Migrated for Hibernation in Districts of Voronezh Region in 1957

District	Date of investigation	Average number of bugs per 1 m²	Fat content of females (in %)
Rossosh'	8 IX	3.9	32.5
"	31 X	—	25.3
Mikhailovka	29 X	3.1	23.6
Kalach	11 IX	2.5	30.8
Buturlinovka	8 IX	3.0	32.9
Belogor'e	9 IX	2.3	—
Ostrogozhsk	7 IX	3.2	32.9
Pavlovsk	10 IX	5.5	31.1
Vorob'ev	19 IX	5.2	31.4
Podgornoe	11 IX	6.5	31.3

The rapid ripening of the cereals led to a premature cessation of feeding of the winged bugs, and consequently to a poor accumulation of fat. Table 5 gives data on the fat content of bugs taken from winter wheat at different times — from the time of appearance of an appreciable number of adults to the end of migration of the bugs to the woods.

As this table shows, the bugs with highest fat content (31.5%) were found on winter wheat on July 5, and on the following day a few began to migrate into the woods. On subsequent days prior to completion of the harvest the fat content of the shield bugs was very low. In such a case the majority of bugs could not fly off to their wintering sites; only a few individuals with a higher percentage of fat migrated into the woods. In autumn 1957 workers of the Plant Protection Station made a survey of the woods in several districts of Voronezh region. In every case they found small numbers of overwintering shield bugs (Table 6).

According to the data of the Prediction Service (Rider, 1958), shield bugs were found in small numbers in woods in all districts of Voronezh region in autumn 1957.

Thus, the shield bug outbreak which began in 1953 ended in 1958 throughout the area of its occurrence in the Central Chernozem Zone.

SUMMARY

1. The shield bug Eurygaster integriceps Put. is widely distributed in the steppe area of the Central Chernozem Zone and causes severe damage to wheat. Its outbreaks have been confined to the southern districts of Voronezh and Belgorod regions.

2. Two outbreaks of this bug have occurred in the last twenty years, one in 1938-1941 and one in 1953-1957. Both outbreaks were similar as regards area affected and the nature of the multiplication.

3. In the south and southwest areas of the steppe regions during the last outbreak the highest numbers of the shield bug in woods in spring after hibernation were recorded in 1956 (more than 100 per 1 m^2, Mikhailovka district), but in autumn of the same year the numbers of the bug in the wood were very small, and in 1957 a depression set in.

4. The sharp reduction in the numbers of the shield bug in 1956 was due to lack of food. In the above-mentioned regions the winter wheat was extensively damaged by frost in the winter of 1955/1956. No spring wheat was sown. The shield bugs emerging from the woods were obliged to live on crops unusual for them — oats, barley, and even maize on which a new generation cannot develop. The larvae develop very slowly on oats and barley, the adults cannot store up fat, and they die before migration to the woods can take place.

5. In the more northerly regions of occurrence of the shield bug the winter wheat crops survived in 1956, and hence the bug continued to multiply in 1957. The weather was dry and hot during the growing period in 1957. It accelerated the ripening of the crop and led to a premature cessation of the feeding of the new generation of bugs. Only a small number of individuals could store up sufficient fat for their migration to the woods.

6. By 1958 the shield-bug outbreak was over in the whole area of its occurrence in the Central Chernozem Zone.

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DEVELOPMENT AND FOOD RELATIONSHIPS OF THE EUROPEAN CORN BORER PYRAUSTA NUBILALIS HB. (LEPIDOPTERA, PYRALIDAE) IN NEW REGIONS OF MAIZE CULTIVATION

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The extension of maize crops into the traditional hemp-growing areas of Byransk, Orel, Tambov and other regions has made it necessary to study the possibility of this crop being attacked by the corn borer Pyrausta nubilalis Hb., which is a serious pest of hemp in these localities. Work in this direction was carried out in 1956 in the Starodub district of Bryansk region, where maize was first introduced into the crop rotations in 1955 and now occupies about 12% of the total arable area. The hemp here is grown for seed or for fiber, mainly the former, and is a very valuable and profitable crop for the collective farms. The work involved field observations on the development of the corn borer and surveys of damage to hemp, maize, millet and potatoes. At the same time experimental investigations were conducted to ascertain the times of development of the corn borer, to find out if the moths showed any preference for particular species of plants for their egg-laying, and to determine the ability of the caterpillar stage of this pest to thrive under different feeding conditions.

In spring 1956 we made surveys of the overwintering stock of corn borer by collecting and opening up the remains of hemp stems and of thick-stemmed weeds from the previous year's hemp fields, which had been left unplowed since autumn 1955, and from the margins of these fields.

Such collections of hemp stem remains were made in places where the female hemp plants had been thrashed—around the seed storehouses.

The infestation of the previous year's hemp stems by the corn-borer caterpillars varied on different areas from 8 to 12%, while the dry overwintered mugwort (Artemisia vulgaris) stems were 9% infested. The number of caterpillars which perished during hibernation did not exceed 4%.

The wintering stock of corn borer in the hemp stalks was unevenly distributed among the fields. The greatest incidence of caterpillars was observed in low lying, moister parts of the fields, areas usually heavily overgrown with weeds. As regards the weeds corn-borer caterpillars were found in the previous year's stems of mugwort and Amaranthus, but only on plants near or among hemp plants, or in kitchen gardens or personal holdings. We did not find any corn-borer caterpillars when we opened up dry stems of mugwort, creeping thistle, or chicory, situated far from the hemp crops — in young tree plantings, on margins separating cereal crops, on the edges of field paths — nor did we find them in the previous year's potato stalks. A search for overwintering caterpillars in the remains of the previous year's maize (stubble, broken stalks, panicles) met with no success. Five thousand stumps and stalks of maize were opened up, but not a single case of damage, nor a single corn-borer caterpillar, was found inside any of them. When we had established that the corn borer was absent on maize in the local conditions of the Starodub district, we traveled to Starchenkovskii district of Kiev region, where we collected 98 live corn-borer caterpillars from the remains of the previous year's maize stalks. These served as material for our experimental work in Starodub district on the feeding of the corn borer from maize as compared with the feeding of the local corn borer from hemp.

TABLE 1

Times and Intensity of Egg Laying of Corn Borer in Field Conditions in 1956

	30 VI	4 VII	9 VII	14 VII	20 VII	25 VII	31 VII	9 VIII	17 VIII	22 VIII
	Number of eggs									
Hemp (50 plants)	0	0	210	650	36	52	11	3	12	0
Mugwort (25 plants)	0	140	350	280	120	17	3	0	0	0
Maize (50 plants)	0	0	0	0	0	0	0	0	0	0

The weather in 1956 was characterized by a late, cold spring, a recurrence of cold weather between June 21 and July 3, and heavy rainfall in July, August and September. The total rainfall for these months was almost twice the average figure for that period from the records of several years.

The pupation of the caterpillars and the emergence of the moths from hemp and maize during the cold weather of the spring period were very irregular. The pupation of caterpillars of the hemp population began with a few cases in late May and took place mainly in the first half of June. The flight of moths of the hemp population began on June 18, but owing to the severe cold and rain between June 21 and July 3 it ceased, and then started up again on July 4-5. The flight was at its height between July 4 and 16, and after that occasional moths could still be found on the fields until mid-August. Surveys of the flight in field conditions showed that the moths were usually found in places where the hemp grew thick and dense. At the time when the moths' flight was at its height the hemp crops were in the 5-6 leaf-pair stage of development, with the upper leaves of the plants forming a canopy; this produced shady and damp conditions within the field. On walking through the crop at this time one could count as many as 5-10 corn-borer moths fluttering up every 100 paces. The moths were also observed on the wing among dense clumps of weeds (Artemisia, Cirsium, Cichorium, Sonchus) on marginal land near the crops, and on vegetable and garden plots. Surveys conducted at the same time on maize showed a complete absence of corn-borer moths in flight among these plants. When the flight of the moth on the hemp was at its peak, the maize was in the 5-6 leaf-pair stage of development, but the fairly thin sowing of this culture by the square-cluster and drill methods practiced in this locality did not attract the corn-borer moths.

For a survey of the egg batches of the corn-borer moth we labeled 50 plants on experimental sowings of hemp and maize and 25 mugwort plants on a personal vegetable plot. From June 30 these plants were carefully inspected every 5 days, the corn-borer egg batches being counted and then removed from the leaves. The results of these surveys are given in Table 1.

The counts showed that the egg laying, which began in early July, first on the mugwort (July 4) and then on the hemp (July 9), was most intense until July 20-25 on both the hemp and the mugwort, after which a few egg batches could still be found on the hemp up to mid-August. On the marked maize plants, which grew alongside the marked hemp plants, no egg batches were found during the whole period of observations, i.e., from June 30 to August 22.

Hatching of the first-instar caterpillars was observed on mugwort on July 8. Further surveys showed that, owing to the protracted flight of the moth on hemp crops and among weeds, caterpillars of various instars developed simultaneously, there being a predominance of instars II and III toward the end of July and of instars IV and V toward the end of August.

Simultaneously with the field surveys and observations on the development cycle of the corn borer in 1956, we experimentally reared (in the same conditions, Starodub district of Bryansk) corn-borer moths which had emerged from pupae of the overwintered generation, collected locally on hemp stalks, and also moths which had emerged from pupae collected from maize stems in the Starchenkovskii district of the Ukraine. To obtain more accurate information on the possibility of hemp-population corn borers multiplying on maize crops, and conversely, maize-population corn borers multiplying on hemp crops, we reared these two populations from the start of pupation of

TABLE 2

Times of Development of Hemp and Maize Populations of Corn Borer in Experimental Conditions

	Pupation		Emergence of moths		Egg-laying		Larval instars				
	Start	Extensive	Start	Extensive	Start	Extensive	I	II	III	IV	V
Hemp corn borer	25 V*	12 VI	9 VI	20 VI	27 VI	30 VI	30 VI	10 VI	18 VII	25 VII	7 VIII
Maize corn borer	8 VI	28 VI	17 VI	5 VII	2 VII	9 to 18 VII	14 VII	22 VII	3 VIII	14 VIII	28 VIII

*The date given is the date of the beginning of the indicated period (except where noted).

the overwintered caterpillars to fully grown caterpillars and pupae of the subsequent generation in the same temperature conditions, alternating between 17 and 25°C, and at relative humidity 75-90%. Here we noted an appreciable difference in the times of development of the corn borers taken from maize brought from Kiev region as compared with those of the local hemp corn borer. This difference can be gauged from Table 2, which gives the data of the laboratory rearing.

As can be seen from the figures given, the development of the corn borer from Kiev region (pupation of caterpillars, emergence and start of egg laying of moths, as well as the hatching and development of caterpillars) lagged approximately 2 weeks behind that of the hemp corn borer. However, the later times of development of the corn borer of the maize population did not mean its depression in Starodub district. As further observations showed, the longevity and fecundity of the maize-population moths even slightly surpassed the longevity and fecundity of hemp-population moths, as we can see from Table 3, which gives the results of counts of the eggs laid in the separate cages.

From these figures we see that neither the moths of the hemp population nor of the maize population showed any distinct preference for a particular crop (maize or hemp) for egg laying. The moths laid their eggs just as readily on the walls of the glass cage, on moist filter paper installed in the cages, or on leaves of hemp or maize growing in the cages. If moths in a single cage were presented with a choice of plants for egg laying (hemp, maize or millet), the maize-population moths preferred maize, and the hemp-population moths preferred hemp; at the same time moths of both populations avoided laying their eggs on millet leaves.

When moths of different populations (hemp, maize, mugwort) were reared together it was found that moths of the hemp population readily mated with moths of the mugwort population; the progeny obtained from this mating were not inferior in fecundity or vitality to the hemp-population progeny, as can be seen from the data in Table 4.

The information given in Table 4 indicates, on the other hand, that when corn borers of the hemp population (Bryansk region were reared together with those of the maize population (Kiev region) the moths were reluctant to mate. The unfertilized females laid a small number of eggs, which did not develop, however, and did not produce larvae. This latter fact indicates that food specialization, and possibly also the climatic conditions to which the hemp and maize corn borers had become adapted, result in a certain measure of isolation of their individuals, and as a result Pyrausta nubilalis Hb. moths prefer to mate with individuals from the same locality. There are references to this in the literature (Painter, 1953).

As soon as the caterpillars hatched out in the cages containing hemp, maize and mugwort populations of corn borer, we set up experiments to find out if they showed any preference for

TABLE 3

Fecundity of Moths of Maize, Hemp and Mugwort Populations of Corn Borer Reared on Different Plants

	Kind of plant in cage	Number of cages	Total number of moths	Longevity of females			Number of eggs laid by 1 female			Number of caterpillars hatched		
				Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
Hemp corn borer	Hemp	5	5♀ 5♂	25	35	13	358	548	150	94	184	50
	Maize	6	6♀ 6♂	17	27	5	212	540	127	89	180	30
	Millet	2	2♀ 2♂	14	—	—	No egg batches					
	Hemp, maize	1	1♀ 1♂	18	—	—	275	—	—	56	—	—
Maize corn borer	Hemp	5	5♀ 5♂	32	46	25	452	600	305	241	322	132
	Maize	8	8♀ 8♂	18	26	13	382	770	190	200	300	97
	Millet	2	2♀ 2♂	16	—	—	38	—	—	No caterpillars hatched		
	Hemp, maize	2	2♀ 2♂	15	18	12	309	403	215	174	250	97
Mugwort corn borer	Hemp, maize	2	2♀ 2♂	12	18	6	320	382	260	258	271	245

TABLE 4

Results of Crossing Moths of Different Populations

Corn borer population	Kind of plant in cage	Number of cage	Total number of moths	Number of eggs laid by 1 female			Number of caterpillars hatched
				Mean	Max.	Min.	
Cross: hemp ♀ X mugwort ♂	Hemp, maize	1	1 ♀, 1 ♂	260	—	—	116
Cross: hemp ♀ X maize ♂	Hemp, maize	4	4 ♀♀, 4 ♂♂	39	78	16	None
Cross: maize ♀ X hemp ♂	Hemp, maize	2	2 ♀♀, 2 ♂♂	15	16	14	None

a particular food plant. For this purpose caterpillars from the egg batches of a single female of the hemp or maize population were reared in separate groups of 30-50 individuals in half-liter or liter jars containing one kind of plant — hemp, maize, millet or mugwort. At the same time we set up several such jars where the caterpillars were provided simultaneously with hemp, maize, millet and mugwort so that they could freely choose their food plant. The caterpillars were reared in the same conditions of temperature, alternating between 17 and 25°C, and relative humidity in the range 80-95%. The times of development of the caterpillars on the different plants and their mortality rate in different instars can be estimated from the data collected in Table 5.

The cited data reveal a very high mortality among first-instar caterpillars in the first few days of their life in all feeding conditions. This is usual for the hemp corn borer, according to published information (Shchegolev, 1934). On the other hand, from the data given in Table 6 we can see that the development of the caterpillars of the hemp and hemp-mugwort populations (cages Nos. 1 and 3) was retarded a little when they were reared on maize and their percentage survival on this plant was a little lower than that on hemp and mugwort. The hemp-population caterpillars developed just as well on mugwort as on hemp. Maize-population caterpillars, on the other hand, developed better on maize than on hemp, and even more so than on mugwort. Millet plants, according to the results of laboratory rearing, were unsuitable for the development of caterpillars both of the hemp and of the maize populations; on this plant all the caterpillars in the experiment died in the early instars.

Thus, the experiments on the rearing of caterpillars under different feeding conditions showed that the development of the hemp-population progeny on maize, just as the development of the maize-population progeny on hemp, is not out of the question. This is indicated by the presence of pupated caterpillars in these series of experiments.

This latter point was confirmed also by the results of our experiments on rearing hemp- and maize-population caterpillars and moths where they were free to select their food plant. These experiments were set up directly in field conditions, mixed crops of maize, hemp and millet being first grown on four experimental plots. Egg-laying moths of the hemp population were introduced under a gauze cage on one such plot. In the same way egg-laying moths of the maize population were released onto a second plot containing a mixed crop of the above plants.

Subsequent observations on the damage done to plants on the plots by the corn-borer caterpillars showed

TABLE 5

Times of Development of Corn-Borer Caterpillars and Their Percentage Mortality (when fed on different plants)

No. of cage	Corn borer population	Kind of plant in cage	Number of caterpillars used	Times for development of caterpillars and percentage mortality in each instar					Time of pupation	End of expt.	Number of live individuals at end of expt.				
				I	II	III	IV	V			caterpillars IV	caterpillars V	pupae	total	in %
1	1♀×1♂ of hemp corn borer	Hemp	20	3—10 VII, 35%	11—22 VII, 10%	23—30 VII, 5%	31 VII—6 VIII, 5%	7 VIII, 5%	18—22 VIII	8 IX	—	4	4	8	40
		Maize	30	3—20 VII, 43%	21 VII—2 VIII, 27%	3—10 VIII, 3%	11—17 VIII, 2%	18 VIII, 3%	26 VIII	»	—	6	1	7	23
		Mugwort	30	3—10 VII, 47%	11—22 VII, 26%	23—30 VII, 0%	31 VII—5 VIII, 0%	6 VIII, 0%	11—18 VIII	»	—	8	1	9	30
		Millet	30	3—20 VII, 86%	21—23 VII, 100%	—	—	—	—	23 VII	—	—	—	—	0
2	1♀×1♂ of maize corn borer	Hemp	50	14—30 VII, 40%	31 VII—6 VIII, 12%	7—17 VIII, 12%	18—27 VIII, 16%	28 VIII, 8%	31 VIII	8 IX	3	2	1	6	12
		Maize	50	14—22 VII, 60%	23 VII—2 VIII, 14%	3—13 VIII, 0%	14—27 VIII, 4%	28 VIII, 2%	—	»	5	5	—	10	20
		Mugwort	50	14—30 VII, 54%	31 VII—6 VIII, 19%	7—17 VIII, 13%	18—27 VIII, 4%	28 VIII, 4%	—	»	2	1	—	3	6
		Millet	50	14—28 VII, 100%	—	—	—	—	—	»	—	—	—	—	0
3	1♀ of hemp corn borer ×♂ of mugwort corn borer	Hemp	25	10—15 VII, 24%	16—27 VII, 16%	28 VII—6 VIII, 16%	7—11 VIII, 4%	12 VIII, 16%	25 VIII	8 IX	—	3	3	6	24
		Maize	40	10—15 VII, 65%	16 VII—2 VIII, 18%	3—10 VIII, 0%	11—24 VIII, 2%	25 VIII, 0%	—	»	—	6	—	6	15
		Mugwort	20	10—18 VII, 40%	19—27 VII, 15%	28 VII—6 VIII, 0%	7—10 VIII, 15%	11 VIII, 10%	18 VIII	»	—	3	1	4	20
		Millet	20	10—20 VII, 70%	21—28 VII, 30%	—	—	—	—	7 VIII	—	—	—	—	0

TABLE 6

Development of Corn Borer When Given a Free Choice of Food Plants

Moth population under cage	Plants on plot under cage	Number of stems opened	Stems damaged		Larval instars found			
			total	in %	III	iv	v	total
Hemp corn borer	Plot No. 1							
	hemp	56	35	62.8	12	17	19	48
	maize	40	12	30.3	1	2	10	13
	millet	111	52	46.8	2	7	10	19
Maize corn borer	Plot No. 1							
	hemp	111	12	10.8	—	4	5	9
	maize	70	46	65.7	48	5	4	57
	millet	160	24	15.0	—	—	12	12

that the hemp corn borers, which mainly attacked hemp, did not avoid maize or millet and developed well on them. The same situation was established also for the maize population which, though preferring maize, developed also in fair numbers on hemp and millet. These conclusions are illustrated by the data collected in Table 6.

In autumn, from the end of August and into September, we conducted comparative surveys of the damage done by corn-borer caterpillars to maize, hemp, millet and potatoes on the collective farm fields of Starodub district. For this purpose we made an extensive inspection of crops of these plants in 5 collective farms in this district. In consequence it was established that while the corn borer multiplied everywhere and in large numbers on hemp, the degree of damage to which varied in different areas from 4 to 66% of the stalks, the maize crops were entirely free from corn-borer damage, even in cases where they were situated alongside heavily infested hemp crops. The millet crops were affected comparatively slightly — from 2 to 14% of the stems were damaged, while on potato crops there occurred rare instances of damage, not exceeding 1%.

At the same time the results of the autumn surveys confirmed those of our spring observations that a breeding and hibernation center for the corn borer in this locality is provided by thick-stemmed weeds (mugwort, sow-thistle, cockspur grass, thistle, Amaranthus), of which the most attractive for the corn borer is the mugwort. These plants are representatives of the weed flora of waste ground, vegetable gardens and the ditches surrounding the personal holdings in the settlements. The infestation of mugwort, according to the results of our autumn survey, was 10 to 75% of the stems, with a density of up to 3-5 caterpillars per stem.

Directly correlated with the heavy colonization of the thick-stemmed weeds, particularly mugwort, on the personal holdings was the clearly uneven distribution of the corn borer on hemp crops, namely: crops adjacent to personal holdings and waste ground suffered most heavily from its attacks. For instance, on the "Leninskii put'" Collective Farm, a 40 ha area of the hemp crop adjacent to the personal holdings was severely attacked, 54% of the stems being damaged, with a density of more than 40 caterpillars per 1 m^2 of crop; at the same time the areas of this extensive hemp sowing furthest from the settlement were very slightly attacked — up to 9% of the stems being damaged. On the other hand, an inspection showed that the low-lying parts of the hemp crops, where the temperature and water conditions were more moderate, were colonized by corn borers to a greater extent than the elevated drier areas. For instance, on the "Pamyat' Lenina" Collective Farm the part of the hemp crop situated on the flood plain round the lake was damaged to the extent of 66.6% of the stems, while on the elevated parts of the same crop, only 28.3-32.5% of the stems were damaged.

SUMMARY

An investigation of the food relationships of the corn borer Pyrausta nubilalis Hb. in Starodub district of Bryansk region in 1956 showed that while this pest developed everywhere and in large numbers on hemp and millet crops, and also on weeds, particularly mugwort (Artemisia vulgaris), the maize crops were totally free

from corn-borer damage, even in cases where they were situated adjacent to heavily infested hemp crops. We also have information on the absence of corn-borer damage to maize in other new districts of its cultivation, for example from the reports of Ilyukhin (1956) from Orel region and of Zhukovskii (1956) from Voronezh region. On the other hand, we discovered in experimental conditions that moths of the hemp population of Starodub district of Bryansk region readily paired with moths of the local mugwort population and gave fertile progeny. At the same time moths of the same hemp population were crossed less easily with moths of a maize population (from Kiev region).

The results cited indicate that there is a certain degree of isolation of the food populations of Pyrausta nubilalis Hb. Practical interest resides in the possibility of adaptation of the hemp population to maize and the maize population to hemp. The latter question has been answered by published information to the effect that in the traditional zone of maize-growing (Kiev, Poltava, Chernigov regions, southern districts of BeloSSR), where the hemp is in some measure a permanent component of the crop rotations, the corn borer, being the main pest of maize, does not refrain from multiplying on the hemp too (Shchegolev, 1934).

As regards the possibility of development of the hemp population of Pyausta nubilalis Hb. on maize, on this point we have only Kozhanchikov's experimental results (1938) indicating the possibility of a full developmental cycle of the hemp population from Novgorod-Severskii district on maize and our own experimental results for 1956 for the Bryansk region. A comparison of these results shows that the adaptation of a hemp population of corn borer to maize is possible. This fact must be taken into account in forecasting the multiplication of this pest in new regions of maize cultivation. It is obvious that in the immediate future Pyrausta nubilalis Hb, will not be a danger to maize crops in hemp-growing regions. However, with further and prolonged introduction of maize crops into the crop rotations of the nonchernozem zone, we cannot rule out the possibility of a gradual changeover of the corn borer from hemp to maize, especially in years of outbreaks, and when the two crops are situated adjacent to each other.

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ROLE OF WILD GRASSES IN THE FORMATION OF THE SPECIALIZED PEST FAUNA OF CEREAL CROPS ON THE TRANS-VOLGA LIMANS*

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Within recent years a start has been made on the cultivation of the liman lands in the Trans-Volga areas of Stalingrad region. The reason for this is the high fertility of the liman soils, irrigated by the runoff of spring thaw waters.

Among the forage crops being sown on the limans perennial grasses are the most important. At the same time large areas are being brought under grain crops, mainly under spring wheat.

Cultivation of new virgin lands in every case leads to a radical reconstruction of the fauna of the area being brought under cultivation. As Bei-Bienko (1954) has pointed out, the main mass of virgin-land organisms are completely destroyed by plowing-up, but a few species of the virgin-land fauna obtain vast new supplies of food in the form of the particular crop. The insect fauna of wild plants genetically, biologically or biochemically related to the crop plant, give rise, as we know (Grigor'eva, 1936; Luk'yanovich, 1938; Gilyarov, 1947, 1955; Zverezomb-Zubovskii, 1950; and others), to complexes of specialized crop pests.

At the present time, along with the areas sown with crops there are still extensive areas of uncultivated grass meadows on the limans. An important element of the meadow grassland composition in the central parts of the limans is couch grass (Agropyrum repens), and on its margins – A. cristatum.

Investigations of the injurious insect fauna on crops and wild grasses were conducted on Bogdanskii, Petrovskii, Valuevskii, Suetinovskii and Savinskii limans situated in the Staraya Poltavka and Pallasovka districts of Stalingrad region.

The formation of the insect pest complexes on grain and grass crops takes place mainly in two ways: firstly, by migration of pests from crops in long-cultivated dry valleys, and secondly, by injurious species which develop in the natural plant associations of the liman meadows transferring themselves to the crops.

According to the closeness of their food relationships with wild grasses the specialized pests of grasses can be classed into four more or less distinct groups.

The first group is composed of cereal pests which have practically lost their food relationships with the wild grasses in the natural plant associations of the liman meadows. The most important of these on the liman crops are: Cephus pygmaeus L., Harmolita eremitum Portsch., Eurygaster integriceps Put., E. austriacus Schrk. The wheat stem sawfly has been noted here on winter and spring wheat, winter rye, and occasionally on barley; the rye jointworm has been recorded only on winter rye; the two shield bugs have been recorded on all the cereals mentioned. This group of insects is not found on wild grasses of the liman meadows nor on forage grass crops.

*The work was carried out in the Laboratory of Agrotechnical Methods of Agricultural Pest Control of VIZR under the guidance of the Laboratory Director T. G. Grigor'eva, Candidate of Agricultural Sciences.

TABLE 1

Generation of flies and dates of counts	Bogdanskii liman					Valuevskii liman	
	Number of larvae per 1 m^2 in grass stems						
	sown			wild			
	spring wheat	Agropyrum tenerum	A. pectiniforme	A. repens	A. cristatum	A. repens	A. cristatum
	Fruit fly						
1st generation, 28/IV-15/VI	196	2	2	2	0.5	2	0.5
2nd and 3rd generations, 25/VI-1/VIII	0.5	1	2	3	1	1	0.2
4th and 5th generations (wintering), 20/VIII-15/IX	—	130	142	55	19	8	4
	Meromyza						
1st generation, 13/VI-25/VI	10	0.2	1	21	0	2	0
2nd and partly 3rd generations (wintering), 28/VIII-15/IX	—	46	63	39	13	6	3

The second group is composed of not very strict oligophages capable of developing on various kinds of grasses — cereal, forage or wild grasses. It includes such pests as Oscinella pusilla Meig., Meromyza saltatrix L., Chaetocnema aridula Gyll. and Ch. hortensis Geoffr., Haplothrips tritici Kurd. etc., and also certain "wild" species associated with steppe or meadow habitats and wild grasses. These include two species of weevils of the genus Mylacus — M. verruca Stev. and M. rotundatus F. and also Phyllobius cylindricollis Gyll., which damage crops on the limans by gnawing the shoots and leaves of young plants of cereal and forage grasses. Crops damaged by them were noted throughout the three years of our investigations.

As an illustration of Bei-Bienko's view that specialized pests which develop on wild grasses in virgin-land habitats obtain particularly congenial conditions for development and increase in numbers when the land is plowed up and crops are sown, we may cite the comparative abundance of the frit fly in 1953 in two types of limans — those partially brought under crops and those still uncultivated.

As we see from Table 1, on Valuevskii liman (Staraya Poltavka district), which is used as a hay meadow, the size of the summer and wintering generations of frit fly, which develops here mainly in the stems of A. repens, and in the stems of A. cristatum on the edges of the liman, is very small. A quite different frit fly population characterizes Bogdanskii liman, which is partially under crops of cereals and forage grasses. Here the summer generations of the fly develop on the cereals, while the wintering ones are found in the stems of the sown and wild grasses. A very indicative feature is that the wintering stock of frit fly in the stems of the same species of plant — Agropyrum repens — in Bogdanskii liman is almost 7 times greater than in Valuevskii liman. The wintering population of frit fly on sown grasses of the genus Agropyrum is particularly high in Bogdanskii liman.

A similar relationship holds in the case of Meromyza saltatrix L. In this case, however, it is not expressed so clearly, thus indicating that this species is much more conservative than the frit fly as regards its food relationships with wild grasses. Sowings of cereals do not offer it the same advantages for an increase in numbers as is the case with the frit fly.

For the cereal flea beetles, the numbers of which greatly increase following plowing and sowing of grass crops on the limans, the wild grasses of the liman meadows are not so much food plants as wintering sites for the adult beetles. From these sites the beetles migrate in spring on to the cereal crops and, owing to their not too strict oligophagy, their larvae are able to develop on various species of grasses sown on the limans. A comparison between the flea-beetle populations of sown and wild grasses on the limans is given in Table 2.

TABLE 2

Date of count	Bogdanskii						Valuevskii liman	
	Number of flea beetle larvae per 1 m^2 in grass stems							
	sown				wild			
	winter wheat	spring wheat	A. tenerum	A. pectiniforme	A. repens	A. cristatum	A. repens	A. cristatum
29 V 1953 . . .	34	4	8	7	0.5	0	0.02	0

In spite of the fact that the wheat thrips mainly colonizes grain crops in the limans, it is always present in small numbers on wild grasses also — on A. repens and on A. cristatum, from which it can always migrate on to sown crops.

A somewhat different position in this group is occupied by weevils of the genus Mylacus (M. verruca, M. rotundatus) and Ph. cylindricollis, which are typical inhabitants of the grass steppes in the regions to the south-east. The first two species are associated in their development mainly with the wild grass A. pectiniforme, while Ph. cylindricollis develops in natural conditions on steppe fescue (Festuca sulcata) also.

These species of weevils migrate on to sowings from the nearest virgin-land habitats and sometimes do considerable damage to the leaf surface of cereal grasses. Nevertheless, these species are hardly likely to complete their life cycle on grain crops. The larvae of these weevils develop among grass roots and feed on them until late autumn. The ripening of the grain crops and the drying-out of the root system takes place long before the larvae have finished feeding, and this is the main reason for their destruction. The spring tillage of the soil also assists in this. We found only small numbers of larvae, and these were on sowings of perennial grasses. The colonization of sowings by the beetles Mylacus and Ph. cylindricollis is limited by their weak migrational ability. All these species of beetles are devoid of wings. Hence, it is hardly likely that their numbers on grain crops will increase, and any damage will be confined to the edges of the crops.

The third group includes species which develop on perennial forage grasses and on genetically related wild grasses. Besides the grass flies Dicraeus tibialis Mg. and D. vagans Macq., which Moiseev (1950) has described as pests of A. cristatum in the Trans-Volga regions, this group also includes the internal stem pests which we were first to record on grass crops: the mordellid Mordellistena pumila Gyll., the buprestids Paracylindromorphus subuliformis Mannh. and Cylindromorphus pyrethri Stierl. and also the sawfly Cephus pulcher Tischb. All these species are associated with wild plants and are of widespread occurrance in the liman virgin-land habitats. At the same time they inflict considerable damage on sown grasses. Of these, Agropyrum pectiniforme is attacked by all these insects, except C. pyrethri, while Bromis inermis and Agropyrum tenerum are damaged by M. pumila and C. pyrethri. The transference of these species to the grass crops is very rapid, this being assisted by the genetic affinity of the sown and wild grasses. The increase in numbers of these insects on grass sowings is due to their observed selective ability to attack the best-developed stems, which are much more numerous in sown areas than in virgin-land habitats. Their economic significance may become greater on seed-grass fields, and in the case of late cutting for hay. Timely cutting of grass kills the larvae developing in the stems.

The fourth group is composed of pests of meadow grasses. It includes the gall eurytomid Harmolita agropyri Schlecht. and other species of gall eurytomids which develop in large numbers on various species of Agropyrum. No less diverse are the eurytomid jointworms. These species must be considered at present as potential pests of sown grasses, and possibly also of cereals, in view of the fact that their food plants in the wild flora are very similar to the grass crops which are being sown on the limans.

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BIOLOGY OF AGRIOTES LITIGIOSUS VAR. TAURICUS HEYD. AND AGRIOTES SPUTATOR L. (COLEOPTERA, ELATERIDAE)

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Click-beetle larvae, the so-called wireworms, are serious pests of several crops. In several regions maize crops are completely destroyed if effective control measures are not employed against them.

In spite of the great economic significance of wireworms the biology of individual species of click beetles has not been adequately studied. Hitherto the number of larval instars was unknown, there was no experimental information on the development of the larvae in relation to temperature, moisture and food, and we had no knowledge of the special features in the development and behavior of the most injurious species. The literature deals with the biology of click beetles in general, and not with individual species. It is well known that without a knowledge of the biology of a pest we cannot take effective measures against it. Hence, in this paper we give an account of the biology and partly of the ecology of the click beetles A. litigiosus var. tauricus Heyd. and A. sputator L., which we studied in Krasnodar territory in the period 1951-1956.

METHOD

The development of the larvae in natural conditions was studied during the 5-year period by periodically digging up samples of soil in the same fields on Krasnodar Fruit and Vegetable State Farm No. 2 (soil — leached chernozem) and from occasional soil samples from different districts (Severskaya, Abinskaya, Yaroslavskaya and others) in Krasnodar territory.

For the laboratory work the larvae were kept singly in large test tubes, jars or 1-liter glass tanks containing moist sand (20-30% of total moisture capacity). The larvae were fed on germinating seeds of winter wheat or, when the effect of food was being studied, on carrot or potato. The sand and food were changed every 3-6 days, and the larvae weighed on an analytical balance. After each molt the head width and body length of the larvae were measured. The eggs were kept on strips of filter paper in test tubes, the lower end of the paper dipping into water in the bottom of the tube. The pupae were kept in their earthen cell or in a test tube with soaked filter paper, the relative humidity of the air in this case being not less than 100%. The beetles were kept in pairs (male and female) in glass jars containing soaked filter paper.

Biology of Crimean Click Beetle (Agriotes litigiosus var. tauricus Heyd.)

In the case of the Crimean click beetle only the larvae of various instars overwinter. In June the last-instar larvae pupate, and in the second half of June and early July the adult beetles emerge from the pupae and come out on to the soil surface after 5-10 days. The beetles do not require further feeding; after pairing the females burrow into the soil to lay their eggs. Fifteen to twenty days elapse from the time of eclosion of the female beetles to the beginning of egg laying. Egg laying lasts 2-4 weeks. The larvae hatch out from the eggs within 20-25 days, and these larvae take about 3 years to develop. The larvae winter three times and pupate in June of the third year of development. One generation takes three years. Some larvae winter once again, and the time for one generation is thus extended to four years.

TABLE 1

Absorption of Water by Crimean Click-Beetle Larvae before Molting

No.	Weight (in mg) after cessation of feeding	Weight (in mg) after absorption of water	During few days before molting	% increase in weight	Weight after molting
1	23	28	9	21.7	29
2	14	17	6	21.4	17
3	34	39	9	14.7	41
4	54	65	10	20.4	66
5	62	71	11	14.3	74
6	33	42	10	27.3	42
7	12	15	8	25.0	15
8	41	54	16	30.1	52
9	13	16	8	23.1	16
10	36	42	15	16.7	43
Average	32.2	38.9	10.2	20.8	39.5

TABLE 2

Distribution of Crimean Click-Beetle Larvae in Soil of Varying Moisture Content

Variants of experiment and wireworm groups	Soil moisture: 10 %	50%	90%
	number of wireworms (in %)		
I. Layer with moisture content 10% at top			
1st group	20	0	80
2nd group	10	80	10
3rd group	40	30	30
II. Layer with moisture content 90% at top			
1st group	90	10	0
2nd group	0	80	20
3rd group	40	30	30
III. Layer with moisture content 10% at top, food in each layer			
1st group	50	30	20

We will examine more fully the relation between the development of the separate phases and the environmental conditions.

Egg. The freshly laid eggs are milky white, oval, 0.9 mm long and 0.45 mm broad. They are of the noncleidoic type and in the first 3-8 days of development they absorb water and increase about half as much again in size. If the soil is not moist enough the eggs cannot absorb water, and they perish. The development of the eggs takes 20 days at temperature 26° and 25 days at 23°. The heat sum required (above 10°) is about 320°. The lower threshold of development is about 10°, and the upper threshold is above 31°.

Larva. The newly hatched larvae have a body length of 2.0-2.2 mm and a head width of 0.12 mm. During development the larvae molt 9-11 times and hence pass through 10-12 instars. When feeding conditions are unfavorable the number of instars increases to 13-15. One instar lasts 8-20 days (for the first five instars) or 30-60 days in the case of the late instars. The rate of development of the larvae is largely determined by temperature and food. At temperature 25-29° the duration of the earlier instars is 7-10 days, and of the later — 20-30 days. At temperature 17-20° the duration of one instar is 20-28 days in young larvae, and 35-60 days in older larvae.

If the larvae do not have sufficient food or if the available food is unsuitable for them, their period of development is greatly prolonged. When fed on germinating wheat the larvae of the Crimean click beetle take an average of 294 days to develop, and when fed on carrot or potato they take 430-450 days, i.e., half as long again. Moreover, when fed on potato the majority of the larvae die, and those which survive molt a greater number of times (up to 14), there being practically no increase in the weight and size in the later instars. Larvae fed on potato only during the later instars pupate, and the pupae produce beetles, but the fecundity of the female beetles is lower than in the case of feeding on wheat. In natural conditions the larvae do not always find sufficient suitable food. If taken into the laboratory and installed in soil containing germinating wheat the wireworms feed vigorously and increase 10-20% or more in weight within 1-3 days.

In each instar click-beetle larvae pass through definite stages of development, which are characterized by a different physiological state and different behavior of the larvae.

1st stage — molting. The newly molted larva in its first 3-6 days (at temperature 18-20°) remains in its earthen cell without feeding and moves about very little. When put into water the larva hardly absorbs any of it and the water supply of its body is not increased. In dry air the larva loses very little water.

2nd stage — intense feeding after molting. Three to six days after molting the larva begins to feed and to increase in weight. During this stage, lasting 15-20 days, the larva remains near food if it is present, and is not very active; if food is insufficient the larva moves about in search of it. At this stage the larval cuticle becomes much more permeable.

TABLE 3

Duration of Development (in days) of Crimean Click-Beetle Larvae Fed on Germinating Wheat (Nos. 1-13 – females, 14-20 – males)

No.	Instar (in days)													Total days	Heat sum (°C)
	1	2	3	4	5	6	7	8	9	10	11	12	13		
1	10	10	14	8	11	15	15	26	38	82	—	—	—	229	3002°
2	18	13	18	14	15	15	20	19	28	34	68	—	—	262	3345
3	19	11	7	10	14	14	24	27	31	33	80	—	—	270	3355
4	14	15	19	17	15	12	30	30	28	50	44	—	—	274	3448
5	14	10	11	19	11	14	29	29	43	28	38	44	—	290	3563
6	14	12	14	9	9	11	20	22	33	36	48	72	—	300	3582
7	17	10	22	9	9	12	19	30	38	56	94	—	—	316	3548
8	24	18	15	10	14	13	17	22	41	54	86	—	—	314	3711
9	18	16	16	18	40	24	48	24	36	43	36	—	—	319	3930
10	14	13	16	13	10	13	15	28	27	27	77	33	42	328	3996
11	10	12	13	10	14	14	19	33	56	40	49	58	—	329	4022
12	12	13	14	13	16	31	29	36	44	82	—	—	—	290	3603
13	13	12	14	19	16	27	27	30	32	42	59	—	—	291	3297
14	18	18	20	13	16	21	51	21	37	42	—	—	—	257	3175
15	20	13	13	7	14	19	35	35	46	59	—	—	—	261	3330
16	19	12	24	14	13	13	27	25	27	24	41	43	—	282	3448
17	10	12	10	10	15	21	30	29	37	124	—	—	—	298	3421
18	10	11	11	11	16	16	30	41	22	43	94	—	—	305	3250
19	13	10	10	16	12	11	11	19	30	38	78	60	—	308	3593
20	16	20	9	11	12	17	15	35	43	32	32	124	—	366	4337
Average days	15.1	13	14.5	12.5	14.6	16.6	25.5	28.5	35.8	43	61.6	62	—	294	3548
Average temperature (°C)	27.5	27.3	27.3	27.2	25.7	24.2	22.5	21.3	21.2	20.3	19.5	18.7	—	—	—

TABLE 4

Development of Crimean Click-Beetle Larvae Fed on Germinating Wheat Seeds (25 larvae)

Index of development	Females			Males		
	average	minimum	maximum	average	minimum	maximum
Time for development (in days)	293	229	329	285	257	308
Number of instars	11.3	10	13	11	10	12
Head width in last instar (in mm)	1.8	1.55	2.1	1.5	1.4	1.7
Weight of larva in last instar (in mm)	62	38	82	36	30	49
Weight of pupa (in mg)	76	55	98	47	36	53
Weight of beetle (in mg)	59	42	79	31	25	37
Heat sum (in °C)	3571	3002	4022	3370	3175	3593

3rd stage – intense activity and little feeding on the part of the larva. During this period, lasting 5-15 days, the larvae make their longest excursions in search of congenial conditions of temperature, moisture and aeration. The permeability of the larval cuticle at this time is a little greater than in the preceding stage. After 1 hour in water the larvae become 15-20% heavier owing to the water absorbed. In dry air the larvae lose water fairly quickly and within an hour their weight drops by 15-25%.

TABLE 5

Development of Crimean Click-Beetle Larvae Fed on Various Foods (40 larvae)

Index of development	Wheat			Potato			Carrot		
	average	minimum	maximum	average	minimum	maximum	average	minimum	maximum
Time for development (in days)	294	229	366 *	430	310	530	450	320	604
Number of instars	11.3	10	13	12.7	11	15	13	12	14
Head width in last instar (in mm)	1.72	1.4	2.1	1.4	1.28	1.52	1.64	1.5	1.8
Weight of last-instar larva (in mg)	52	30	82	26	16	37	55	49	59
Weight of pupa (in mg)	66	36	98	31**	27	37	56	40	63
Heat sum (in °C)	3548	3002	4337	4890	3800	6332	5600	4646	6400

Note: *The larvae diapaused for more than two months.

**Pupation only took place when the larvae were fed on wheat in the early instars.

TABLE 6

Head Width (in mm) of Crimean Click-Beetle Larvae (larvae Nos. 1-13 gave females, 14-20 gave males)

No.	Instar												
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th
1	0.12	0.18	0.24	0.31	0.42	0.51	0.77	1.0	1.32	1.7	—	—	—
2	0.12	0.17	0.23	0.30	0.36	0.43	0.65	1.85	1.06	1.28	1.55	—	—
3	0.12	0.20	0.26	0.33	0.43	0.56	0.74	0.96	1.28	1.42	1.80	—	—
4	0.12	0.21	0.30	0.39	0.47	0.7	0.9	1.25	1.42	1.7	1.9	—	—
5	0.13	0.20	0.30	0.45	0.6	0.75	1.05	1.3	1.54	1.7	1.85	1.97	—
6	0.12	0.18	0.25	0.32	0.4	0.56	0.8	1.0	1.43	1.65	1.9	2.1	—
7	0.12	0.18	0.25	0.32	0.48	0.65	0.9	1.2	1.5	1.72	1.95	—	—
8	0.12	0.17	0.22	0.29	0.37	0.52	0.76	0.95	1.28	1.5	1.85	—	—
9	0.12	0.20	0.27	0.32	0.37	0.48	0.67	0.92	1.3	1.45	1.75	—	—
10	0.12	0.16	0.23	0.30	0.4	0.5	0.7	0.93	1.1	1.3	1.46	1.7	1.8
11	0.12	0.18	0.26	0.32	0.48	0.6	0.86	1.1	1.35	1.56	1.8	2.03	—
12	0.13	0.20	0.30	0.45	0.7	0.9	1.12	1.43	1.6	1.8	—	—	—
13	0.13	0.20	0.32	0.43	0.52	0.72	0.95	1.1	1.85	1.54	1.72	—	—
14	0.12	0.23	0.32	0.4	0.5	0.68	0.9	1.0	1.22	1.4	—	—	—
15	0.12	0.20	0.32	0.42	0.65	0.8	1.0	1.25	1.4	1.5	—	—	—
16	0.12	0.18	0.26	0.33	0.41	0.52	0.6	0.88	0.9	1.1	1.28	1.43	—
17	0.12	0.17	0.26	0.32	0.45	0.6	0.87	1.05	1.28	1.45	—	—	—
18	0.13	0.21	0.30	0.37	0.47	0.56	0.87	1.12	1.25	1.4	1.65	—	—
19	0.13	0.22	0.31	0.38	0.52	0.65	0.76	0.93	1.18	1.38	1.5	1.7	—
20	0.12	0.18	0.26	0.32	0.45	0.52	0.7	0.85	0.95	1.03	1.27	1.4	—
Average for female	0.12	0.19	0.26	0.35	0.45	0.60	0.84	1.10	1.35	1.56	1.8	2.0	—
Average for male	0.12	0.20	0.29	0.36	0.49	0.62	0.81	1.0	1.17	1.32	1.42	1.55	—

4th stage — preparation for molting. For 5-10 days prior to molting the larvae become almost completely inactive inside the earthen cell which they have constructed. The tunnels leading into the cell remain open and the larvae occasionally crawls along them. At this stage the larvae absorb water and their weight increases by 20-30%. The water absorbed by the larvae is tightly bound in the organism and there is practically no diminution in weight after molting. In dry air the larvae lose water fairly quickly (more quickly than at the 3rd stage), but on submersion in water they absorb less water than at the 3rd stage.

TABLE 7

Heat Sum (in °C) Required for Development of Click-Beetle Larvae (Nos. 1-13 females, 14-20 males)

No.	Instar													Heat sum
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	
1	190	171	242	135	192	225	225	296	458	870	—	—	—	3002°
2	324	221	318	234	219	219	220	220	312	364	694	—	—	3345
3	153	170	198	123	167	200	210	288	324	360	346	816	—	3355
4	252	255	338	255	220	169	333	351	300	535	440	—	—	3448
5	252	176	187	338	185	204	368	348	500	297	369	339	—	3563
6	228	197	238	162	153	181	294	264	379	378	518	590	—	3582
7	306	180	187	157	150	174	278	333	437	594	752	—	—	3548
8	418	299	262	166	203	195	187	255	471	567	688	—	—	3711
9	308	269	285	306	536	278	514	259	381	421	374	—	—	3930
10	252	221	288	224	166	188	225	308	313	283	785	323	420	3996
11	170	208	234	174	231	210	228	363	644	420	490	650	—	4022
12	192	234	242	195	245	465	319	416	475	820	—	—	—	3603
13	208	216	242	285	232	292	305	315	330	400	472	—	—	3297
14	306	315	312	195	208	235	561	227	392	424	—	—	—	3175
15	360	221	234	122	235	279	420	410	506	543	—	—	—	3330
16	342	204	422	230	190	183	297	290	283	260	394	353	—	3448
17	190	205	173	169	262	315	345	348	385	1029*	—	—	—	3421
18	160	153	198	192	250	234	345	246	238	473	761	—	—	3250
19	234	178	160	280	204	165	228	345	437	741	456	—	—	3593
20	288	360	153	189	200	243	219	490	473	333	1066 *	—	—	4337
Average	256	223	246	206	223	233	303	313	397	490	546	574	—	3548
Duration (in days)	15.1	13	14.5	12.5	14.6	16.6	25.5	28.5	35.8	43	61.6	62	—	—
Average temperature (in °C)	27.5	27.3	27.3	27.2	25.7	24.2	22.5	21.3	21.2	20.3	19.5	18.7	—	—

Note: * The larvae diapaused for more than two months (ceased feeding and did not pupate).

It should be especially noted that the larvae only absorb water and increase in weight during preparation for molting. Whereas they absorb no water when kept in damp soil during any of the preceding stages, in the fourth stage there is a great absorption of water, and hence the larvae actively control the admission of water to their bodies (Table 1).

The establishment of the development stages during one instar is of importance for the study of wireworm migrations and for assessing the effectiveness of insecticides. Kozhanchikov (1953) showed that in the molting period wireworms and other insects were resistant to DDT.

The literature contains contradictory experimental results on the selection of soil layers of particular moisture content by wireworms (Prints and Bobinskaya, 1936; Gilyarov, 1949; et al). These investigators obtained different results because they did not take into account the physiological state of the experimental larvae. The experiment which we conducted on the selection of soil of different moisture content by wireworms showed that their distribution in the soil layers depended on the physiological state of the larvae. Larvae of 8-10 instars of the Crimean click beetle were divided into 3 groups before the experiment: 1) feeding larvae; 2) those which had ceased to feed but were still active and 3) inactive larvae (before molting and after molting). Batches of 10 larvae of each group were installed in cylindrical glass vessels of diameter 6 cm and height 30 cm; 4 of these larvae were placed in the layer with 10% moisture (i.e., 10% of total capacity) and 3 larvae each in layers

TABLE 8

Fecundity and Time Required for Ripening of the Crimean Click Beetle

No. of female	Ripening (in days)	Average temp. (in °C)	Heat sum above 12°	Eggs laid	Time for egg laying (in days)	Life span (in days)
1	43	18	258	57	18	64
2	25	20.4	210	4 *	5	36
3	16	22	160	39	25	46
4	21	21	189	157	23	47
5	30	23	330	137	15	45
6	34	23.2	381	8 *	10	45
7	20	20.5	170	91	25	45
8	24	23	264	370	15	40
9	28	21	252	128	3	32
10	19	20.5	161	212	18	37
11	20	21	180	209	5	29
On average	25	21.2	232	120	15	42

Note: *More than 120 ripe eggs were found when the insect was cut open.

with moisture content 50-90%. Each layer of sand was 8 cm thick. The temperature during the experiment was 21-24° (Table 2). A count made after three days showed that wireworms of the third group (molting), remained where they were, irrespective of the soil moisture content. The majority (80%) of wireworms of the second group (those which had ceased feeding) were concentrated in the layer with 50% moisture. Wireworms of the first group (feeding group) were concentrated mainly in the lower layer irrespective of what the moisture content was there (10 or 90%). In a variant of the experiment, where food was placed in each layer for the feeding larvae, the wireworms were found in all the layers, but the majority were found in the top layer where the soil moisture was 10%. The concentration of wireworms in the top layer of low moisture content was probably due to the better aeration and the relative ease with which the larvae can move through such soil. Quiescent larvae will, of course, not come in contact with BHC dust introduced into the soil and will remain alive. At temperature 15-17° the period of inactivity in each instar lasts 15-20 days. Hence, in tests of the effectiveness of BHC, some larvae always remain alive 10-15 days after application of the poison.

The activity of Crimean click-beetle larvae is related to the temperature in the following way. At temperature below + 7° the larvae fall into a state of cold torpor, and at + 8° they show very little activity. The larvae begin to move around at + 9-10°, and begin to feed at temperatures above + 10°. The larvae are most active at 24-30°. At temperatures above 32-34° the activity and development of the larvae are suppressed. Above 40° the larvae fall into a state of hot torpor. Temperatures below − 3 to − 4° are fatal to the larvae. Hence, the development of Crimean click-beetle larvae can only take place at temperatures above + 10° and below 30-32°. Below 10° the wireworms do not feed, but move about and expend energy, and this results in a 5-13% loss of weight. Wireworms which have become emaciated during the autumn-spring migration begin to feed intensely when the temperature rises in spring, and hence they seriously damage newly sown crops.

When kept in laboratory conditions at temperature 15 to 31° and fed with germinating wheat seeds three broods of Crimean click beetles were obtained during the 3 years. Larvae were collected in autumn 1953 in the environs of Krasnodar, and in May 1954 the beetles emerged. One of the females laid more than 370 eggs. From larvae which hatched on June 11, 1954 we obtained beetles in May 1955. From the female beetles we obtained eggs from which larvae hatched out in June 23, 1955 and gave beetles in May 1956. From the eggs laid by these beetles larvae hatched out on July 6, 1956, and by October 1956 these larvae had reached their 6th-8th instar.

Investigations were made on larvae which hatched out in July 1954; we determined the duration of each instar, the size of the larvae and their behavior at different developmental stages during one instar (Tables 3-7).

The development of larvae which gave rise to females took 229 to 329 days, the average being 293 days. The development of larvae which gave rise to males took 257 to 308 days, the average being 285 days. The heat sum (above 10°) required varied between 3002 and 4022°; the average heat sum for larvae producing females was 3571°, and for males 3370°.

Pupa. Crimean click beetle pupate in June at a depth of 10-20 cm. The pupa is found in an earthen cell made by the larva. The pupa does not absorb water, but the larva absorbs water before pupation and increases 18-26% in weight. Normal development of the pupa takes place at a relative humidity of the soil air not less than 100%. In dry air the pupa rapidly loses water and perishes. At an average temperature of 21° the male pupae take 11 days to develop, and the female pupae 14 days. The average heat sum for male pupae is 121°, and for female pupae 154°. The low temperature threshold for pupal development is about 10°.

Beetle. Although the female bettles do not require additional feeding the eggs are unripe when the females

TABLE 9

Development of A. sputator Larva

Instar	Duration (in days)	Temperature (in °C)			Heat sum (above 10°)	Head width (in mm)	Body length (in mm)
		average	minimum	maximum			
1st	13	28.0	24	30	234	0.12	1.8
2nd	10	27.3	26	31	173	0.18	2.8
3rd	12	27.4	25	30	209	0.22	3.7
4th	8	26.6	25	28	133	0.29	4.5
5th	8	24.7	24	27	118	0.33	5.0
6th	18	24.5	24	27	261	0.37	5.7
7th	17	22.6	18	25	214	0.47	7
8th	24	21.7	17	25	281	0.58	9
9th	28	21.6	18	28	325	0.9	11
10th	39	20.7	18	23	417	1.03	14
11th	90	20.3	17	23	927	1.25	18
Sum	267	22.3	17	31	3292	—	—
Pupa	10	22	21	24	120	—	—

emerge. After leaving the pupal skin the Crimean click beetles remain for some time in the pupal cell, and 5-10 days later come out on to the soil surface. At temperature 22° the females begin to pair 9-19 days after leaving the pupal stage, and egg laying begins after another 4-13 days. The fecundity of the females is fairly high. Of the 11 females in the experiment 2 laid more than 200 eggs each, and 1 female laid more than 370 eggs. The ripening of the females at an average temperature of 21.2° took 25 days, and the heat sum (above 12°) was 232° (Table 8). The egg-laying period lasted 3 to 25 days and the total lifetime of the female beetles was 29-64 days.

The flight of the beetles takes place in July to early August. In the later part of the day (from 4 to 6 p.m.) the beetles can be found on plants; before sunset the males make short flights. The flight is at its height in the evening, 20-30 minutes after sunset; during this time pairing takes place and the females fly off in search of suitable egg-laying sites. The beetles do not feed. For egg laying the females select sites with sparse vegetation and loose soil occupied by vegetable crops. The female beetles do not fly to lucerne or wheat crops.

The larvae hatch from the eggs in August. By autumn the larvae have attained their 2nd to 3rd instar and overwinter. The larvae winter a second time in the 5th-7th instar, and a third time in the 8th-10th instar. The larvae pupate in June in the third year of development. Some larvae do not pupate and overwinter a fourth time; the generation in this case lasts 4 years.

The heat sum for the development of the eggs is 320°, for larvae 3571°, for pupae 154°, for ripening of the females 232°, and for the whole cycle 4277°. In the environs of Krasnodar the heat sum (above 10°) in the soil amounts to 1600-2000° in the summer period, and hence the heat sum required for the completion of one generation is only reached after 3 years. Of course, no strict relationship between the time for one generation and the heat sum in natural conditions can be found in view of the fact that the larvae in summer occupy layers with different temperatures and because the time for larval development is also governed by the food supply.

Observations have shown that wireworms undertake considerable vertical and horizontal migrations in search of congenial conditions. It is generally believed that vertical movement through the soil layers is governed by the temperature conditions and the soil moisture; when the surface layer of soil is dry the larvae make for the lower levels. The autumn migration into the deeper layers is brought about by the fall in the soil temperature and in the case of the dusky click beetle (Agriotes obscurus L.) begins at 9° (Shchegolev, 1955). However, in several cases we find a totally different relationship between temperature and the vertical distribution of wireworms. It must not be forgotten that the behavior of wireworms is largely determined by their food requirements. In view of the fact that the greatest movements of wireworms are made in search of food, it becomes understandable that they should be found in soil layers with high temperature and low moisture content, if food is available there and the wireworms require it at that time. We marked wireworms with black India ink by drawing the segments apart and brushing the ink on to the intersegmental folds. We often found that if the larvae encountered food in their path they stayed near it. When food was absent the later-instar larvae accomplished considerable horizontal migrations. In loose soil at temperature 23-29° they traveled an average of 1 m in 24 hours. In compact soil (dry chernozem) they could not travel more than 6-10 cm in the same time. If in studying the vertical distribution of wireworms we take into consideration not only the temperature and water conditions in the soil, but also the role of food, then it becomes clear why wireworms are found in different layers of soil under different crops. They occupy the top layer under winter cereals in early spring, under tobacco—

in late spring (after transplanting), under vegetables – in spring and summer, and under tomatoes – in spring (after transplanting) and autumn (under fallen fruits),under peanuts – throughout the summer, owing to food always being present (peanut seeds). Our observations showed that when food is present in the top layer the majority of wireworms (at the feeding stage) of the Crimean click beetle stay in this layer even at temperature 28-30°. When the period of intense feeding is over, however, the distribution of the larvae becomes dependent on the temperature.

In autumn the high temperature of the lower layers of soil and the fall of temperature to + 7-9° in the top layers cause the Crimean click-beetle larvae to migrate deep into the soil. Feeding wireworms, however, remain near the food plant and overwinter there. If the winter fall of soil temperature is not fatal to the larvae, they begin to move about and feed when the soil begins to warm up in spring,i.e., they damage crops. Warming of the deeper soil layers to + 8-9° causes the wireworms which have overwintered there to ascend. The wintering of some of the larvae in the top soil layer accounts for the finding of wireworms around plants in spring, when the temperature in the deeper layers has not risen enough to cause the larvae to migrate upward. Larvae taken from the surface layer of soil in late autumn and brought into the laboratory fed vigorously, while those which had migrated deep into the soil fed comparatively little.

In different years, depending on the fluctuations of temperature, soil moisture and food supply, we find a difference in the vertical distribution of wireworms. The warmer conditions in spring 1952 brought the wireworms up as early as the first ten days of April. In August-September the upper layer of soil was comparatively moist and the wireworms were found there.

In 1954 the ascent of the wireworms took place in mid-April. During May and June they were found in the upper (1-10 cm) layer. In July the larvae remained in the upper layer in moister areas, and on the drier areas some remained around the roots of weeds while the others migrated downward into the soil. In August, there being no rain, the top layer of soil was rather dry and the wireworms were found in the deeper layers (10-30 cm). Wherever rotting plant remains occurred, the wireworms remained near them. In late September to early October the top layer was wetter and the larvae were concentrated in it, and in mid-October they began their downward autumn migration.

When the feeding conditions were unfavorable the larvae were found in a state which could be described as a diapause. The larvae did not eat during this period even when food was available; they were comparatively inactive and for a long time (3-6 or more months) did not molt into the next instar. During this time the non-diapausing larvae had managed to molt 2-4 times. After a long period in diapause the larvae absorbed water, increased 20-30% in weight, and after 5-7 days molted. After molting they began to feed normally and after a certain time molted into the next instar. The state of diapause differed primarily from that of fasting when food was short in that fasting larvae, when food was available, began to feed and molted after a certain time, while the diapausing larvae did not feed. The diapause is an adaptation to help the wireworms to survive uncongenial conditions. This, of course, leads to an extension of the time for one generation.

Cannibalism may occur among Crimean click-beetle larvae. When food is insufficient and the larvae are congested they may eat individuals of their own species. In laboratory conditions larvae which had molted into the second instar fed on 1st-instar larvae which were preparing to molt. Cannibalism was also manifested among later-instar larvae. An experiment was undertaken to determine if the larvae could develop by feeding only on individuals of their own species. Crimean click-beetle larvae of the last two instars were given only other larvae as food. Larvae fed on such food developed normally and pupated, and the female beetles which emerged were fertile. The phenomenon of cannibalism requires a careful study in field conditions. There is no doubt that reports in the literature of lengthy survival of wireworms without food can be attributed to cannibalism.

Biology of Agriotes sputator L.

In the case of A. sputator, larvae of various instars and adult beetles overwinter. The beetles come out onto the soil surface in April and are found up till July. Ripening of the females takes more than 10-20 days at temperature 21-25°. The female beetles do not require further feeding,and in May to early June they lay their eggs. In June-July the eggs produce larva which by autumn attain their 3rd-4th instar and overwinter. The following summer the larvae develop to the 6th-8th instar and again overwinter. In their third summer some larvae attain their last instar and pupate in July, while others which have not succeeded in completing their

development, overwinter a third time and pupate in the following summer. The time for one generation is three or four years.

A fuller acquaintance with the development of the separate stages of A. sputator shows that in several respects it resembles that of the Crimean click beetle, for instance, in the absorption of water by the eggs and larvae, the number of instars, the similar developmental stages during one instar, and in certain other aspects. At the same time there are differences in the activity and rate of development in relation to temperature, in the behavior of the beetles after emerging, in the increase in size of the larvae after molting, and other features.

Egg. The freshly laid eggs are milky white, oval, 0.6 mm long and 0.3 mm broad. In the early days of development the eggs absorb water and increase half as much again in size, mainly in girth. The eggs develop in 22 days at an average temperature of 24°, and in 27 days at temperature 21.4°. The heat sum (above 10°) required is about 300°.

Larva. Newly hatched larvae have a body length of 1.8-2.0 mm and a head width of 0.12 mm. During the period of development the larvae pass through 11-12 instars. At temperature + 6-7° A. sputator larvae fall into a state of cold torpor, and at + 8-9° they begin to move about. The upper temperature threshold for development is above + 31°. The optimum temperature, at which the larval development is most rapid, is 25-28°. The larvae begin to feed at 10°; this temperature is also approximately the low temperature threshold for development.

In laboratory conditions the larvae developed well when fed on germinating wheat seeds. At average temperature 20-26° (range of variation 16-31°) the larvae took 260-305 days to develop. The heat sum (above 10°) was 3200-3700°. The difference in the times of development of the larvae was probably due to certain differences in the feeding conditions with food that was apparently the same in the same set of experiments. The fact is that the larvae sometimes feed only on the young juicy radicles of the wheat, sometimes on the endosperm and inside the seed, and sometimes they attack the young stem. We know that different parts of the plant contain different amounts of organic matter (proteins, carbohydrates, etc). Hence, even when the food is more or less of one kind there will be some difference in the build-up of fat-protein stores in the larvae. This question, however, will require special study. As an example we can only cite a comparison of the rate of development of two larvae. When both larvae were kept in the same conditions one larva developed to its 8th instar in 86 days while the other took 128 days before molting to the 8th instar. One larva of A. sputator passed through 10 instars in 172 days and then took 193 days to develop through another instar (the last). The heat sum for the first 10 instars was 2305°, and for one (11th) instar was 2354°, i.e., more than for the first 10 instars. This larva diapaused in the 11th instar, and its weight did not increase over a period of 120 days, after which the larva absorbed water, increased in weight by 20%, and pupated after 5 days.

Table 9 represents the most typical development of one larva.

Pupa. A. sputator larvae pupate in July or August. The depth at which they pupate depends largely on the soil moisture. Since the top layer of soil is usually drier in summer the larvae move down to a depth of 10-20 cm or more, and there they pupate. The pupal stage lasts 8-12 days at temperature 21-25°.

Beetle. Beetles which emerge in summer remain in the soil through the winter and come out on to the surface in the following spring. The rate of ripening of the females was rather difficult to establish in view of the fact that they overwinter and their lifetime is very long. We did observe, however, that female beetles which emerged in the laboratory laid eggs the same summer. Thus, we can infer that the winter fall in temperature is not essential for the ripening of the eggs.

A. sputator beetles are crepuscular insects. During the day they hide under cover on the soil surface, and in the evening they emerge from these shaded spots and fly about. Males can sometimes be found on plants during the day, but females do not leave the soil surface till after sunset; copulation takes place at this time. The fertilized females burrow into the soil or fly off in search of egg-laying sites. Females can often be seen crawling over the soil surface, the most favorable conditions for such movement being areas with sparse grass cover. The beetles do not feed, but in the laboratory they drank water.

Taking the heat sum required for development of the pupae as 120°, for ripening of the females as 200°, development of eggs as 300° and of larvae as 3300°, we obtain the heat sum for the development of one generation as 3920°. This is a little less than that required for one generation of the Crimean click beetle. It is quite

understandable that a species which extends further north (A. sputator) requires rather less heat for the development of one generation.

SUMMARY

In conclusion we should note that the combination of field observations with laboratory experiments provides the best opportunity for a full study of the biology of soil insects. The apparent difficulty of rearing soil insects in the laboratory can be attributed to the fact that the requisite conditions of feeding and soil aeration are not always provided in the laboratory. The greatest difficulty resides in the length of time required for the development of one generation (10-12 months, or more). A study of wireworms in laboratory conditions has shown that only in this way can we make the most rapid and thorough study of their development in relation to temperature, moisture and food. By such study we have succeeded in establishing the number of larval instars, the absorption of water by eggs and larvae, the effect of food on larval development, and other aspects of the life and behavior of wireworms. The discovery of these special features will certainly assist in the elaboration of more effective control measures against such serious pests as wireworms.

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THE HAWTHORN TORTRIX (CACOECIA CRATAEGANA HB.) A PEST OF FRUIT CROPS

E. M. Markelova

The group of tortrix moths which attack fruit crops has become very widespread in recent years, and in certain fruit-growing regions members of this group come second only to the codling moth in the damage they cause. Nevertheless, the biology of tortrices and control measures against them have received little study, particularly in the orchards of the central zone of the European USSR. As a result of the investigations which we conducted between 1954 and 1956, we discovered that the following species of tortrices (besides the codling moth) attack apple trees in orchards of Moscow region:

1) "Rose tortrix" – Cacoecia rosana L.
2) "Hawthorn tortrix" – Cacoecia crataegana Hb.
3) "Gold-variegated tortrix" – Cacoecia xylosteana L.
4) "Omnivorous tortrix" – Cacoecia podana Sc.
5) "Leaden-striped tortrix" – Cacoecia lecheana L.
6) "Reticulate tortrix" – Cacoecia reticulana Hb.
7) "Willow tortrix" – Pandemis heparana Schiff.
8) "Current tortrix" – Pandemis ribeana Hb.
9) "Bud tortrix" – Tmetocera ocellana F.
10) "Fruit tortrix" – Argyroploce variegana Hb.
11) "Frosted tortrix" – Exapate congelatella Cl.

The hawthorn tortrix has been studied least. In both our own and foreign literature only a few scattered records in lists of pests refer to this species.

The hawthorn tortrix has been recorded as a pest of fruit crops in Leningrad region (Shevyrev, 1891), Ul'yanovsk (Pastukhov and Petrova, 1927), Omsk (Shvetsova, 1950), in the Lower Volga region (Fridrikhson, 1937; Sakharov, 1947), South Ural region (Martynova, 1952), the Ukraine (Efremova, 1955), in Simferopol' (Mokrzhetskii, 1911), Astrakhan (Sakharov, 1914), and Moldavia (Bichina and Markelova 1957).

It is also found in Greece, Japan, China, England, France and Czechoslovakia. According to Blattny's data (Blattny and Stary, 1944), the hawthorn tortrix has become more widespread and more injurious since 1937.

In Soviet literature there are reports of it causing considerable damage in orchards in the Lower Volga region, where the infestation of trees by it reached 90% (Sakharov, 1947). Martynova (1952) considers this pest to be common in the flood-plain woods of the South Ural region. The hawthorn tortrix was widely distributed in the orchards of the central zone (Moscow, Tula, Kaluga regions) in 1953-1955.

We conducted research on the biology and ecological characteristics of the hawthorn tortrix in orchards of the Moscow region in 1955. The adverse winter conditions of 1955/56 caused an almost total mortality among the overwintering egg batches, and as a result the caterpillars of the hawthorn tortrix were of rare occurrence in the subsequent years.

Description of Developmental Stages

The adult hawthorn tortrices, especially the females, are larger than other species of tortrices. The female attains a wing span of 26-28 mm, the male 19-21 mm.

The ground color of the forewings varies from brown to greyish brown. In the female a broad brownish median bar on the forewings extends from the hind-to the foremargin of the wing. In the male the spots are velvety and dark brownish. The median bar does not extend to the foremargin of the wing (Fig. 1). The wing pattern of the male is more clearly outlined than in the female. The hindwings are grey with a pale yellow foremargin.

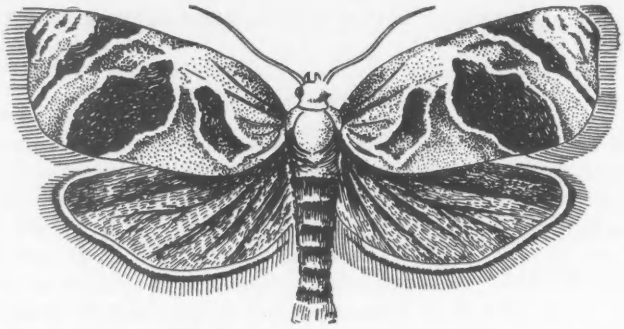

Fig. 1. Male hawthorn tortrix.

Fig. 2. Egg batch of the hawthorn tortrix.

The eggs are pale yellow with a very fine membrane; they are laid in batches of 10-70 (32-54 on the average), closely adpressed to one another, and have a 3-to 5-sided shape according to their position. The underside of the egg is flat and narrow, while the upperside is convex and a little broader. The height of the egg is 0.7 mm, the width 0.55 mm in the upper part, 0.45 mm in the lower part.

Seen from below the egg batch recalls a honeycomb. The individual eggs are cemented together by a white, brittle, waxy substance. The female deposits a fine layer of this substance under the egg batch, and covers the whole batch with the same substance. The thickness of the top layer is 0.1 mm at the edges and 0.2 mm in the center.

In external appearance the egg batches resemble spots of lime or the droppings of small birds (Fig. 2).

The newly hatched caterpillar is greyish yellow in color. The head is black, the thoracic shield grey, the anal shield of the same color as the body.

The 2nd-instar caterpillar is of a grey color with a black head and a black thoracic shield. The anal shield is slightly darker than the ground color of the body.

Caterpillars of the 3rd-to 4th-instars are very variable in coloration. They may be light grey, shining matt grey or greyish green. The head, thoracic and anal shields, as also the thoracic legs, are shining. The tubercles on the body are small and black. The caterpillars may change color after molting; some of them become a dense velvety black; this coloration disappears after a few days.

Fifth-instar caterpillars attain a length of 22-25 mm. They are dirty greenish or dark grey with a greenish tint; the head, shields and thoracic legs are shining black. The tubercles are of the same color or slightly darker than the body.

The pupa is dull black and attains a length of 15-16 mm in the female, and 11-12 mm in the male. On the dorsal side of each abdominal segment II-VIII there are 2 transverse rows of spinules. The spinules of the hindrow are shorter than those of the forerow. The wing covers are short, reaching the end of the 3rd abdominal segment and taking up only one third of the total length of the pupa. The cremaster is strongly produced and bears 4 crochets on the end. Two pairs of similar crochets are situated on the sides.

Fig. 3. Damage to leaves of apple and pear by fully grown caterpillars of the hawthorn tortrix.

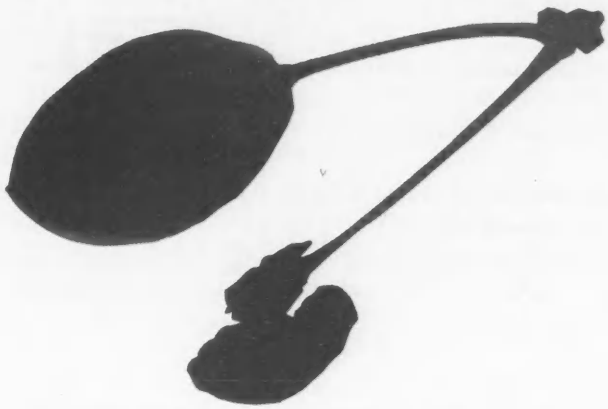

Fig. 4. Damage to plum fruits by the hawthorn tortrix caterpillar.

Mode of Life

In the conditions prevailing in the central zone the hawthorn tortrix has one generation in the year. In England, according to Hey and Thomas (1933) it also produces one generation a year. In basic features its mode of life is similar to that of the rose tortrix which commonly occurs in our orchards.

It winters in the egg. In 1955 the caterpillars began to hatch out at the same time (May 15) as those of the rose tortrix, the average air temperature being 16.2°C. The hatch lasted for 13 days, being at its height in the first 7 days, and thus coinciding with the elongation separation stage of the buds.

The newly hatched caterpillars crawl over the crown of the tree and feed on the leaves and buds. Caterpillars of instars 1-3 turn over the edge of young leaves and cement it down with silk to form an enclosure inside which they feed. Caterpillars of the later instars (4th-5th) fold single leaves along the midrib (Fig. 3). Encased in web between the halves of the leaf, the caterpillars gnaw the leaf margins, usually round the apex. On pear and plum they very often damage the fruits too, by eating out deep wide wounds. Damage to apple fruits was less often observed (Figs. 4, 5).

The injurious period of the caterpillars lasts about 50 days. The first pupae were found in the field in late June, inside the leaves in which the caterpillars had fed. The pupal stage lasts 10-12 days at temperature 18-19°.

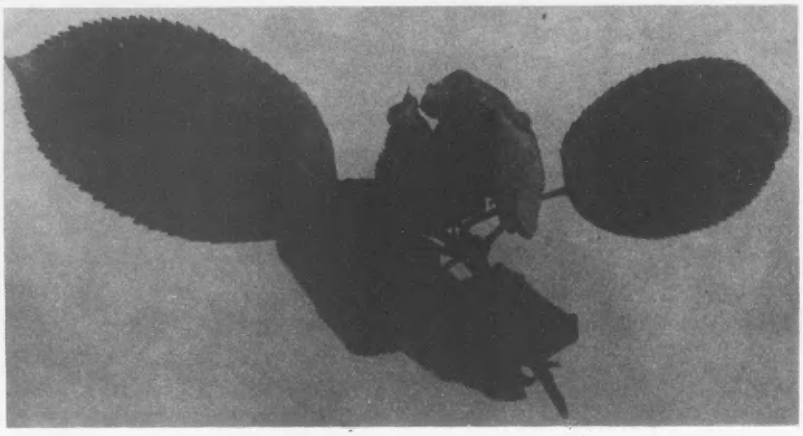

Fig. 5. Apple inflorescence damaged by the hawthorn tortrix caterpillar.

Treatment	No. of batches counted	Total number of eggs in batches	No. eggs giving caterpillars	% Hatch		Effectiveness of treatment (in %)
				actual	control	
Machine oil emulsion						
4%	18	437	415	94.9	96.2	3.8
6%	39	844	694	82.2	83.3	16.7
8%	17	413	268	64.8	65.7	34.3
Carbolineum emulsion						
6%	36	929	852	91.7	93.0	7.0
8%	19	530	482	90.9	92.2	7.8
10%	23	562	503	89.5	90.8	9.2
Control (no treatment)	40	1156	1140	98.6	100	—

The adult hawthorn tortrices, like other tortrices, are active at twilight and at night, and they fly to a bait of dried fruits soaked in fermenting wine, or to fermenting treacle. The start of the flight was recorded on July 9, and the end of the flight on August 4. The flight was at its height in mid-July at an average air temperature 17-19°C. Among the moths caught on bait (217 moths) there was a predominance of males, their number constituting 78.6% of the total.

The moths are sexually ripe on emergence and proceed to egg laying within 2-4 days. The potential fecundity of one female varied from 130 to 270 oocytes (219 on average), but the number of oocytes with visible yolk amounted to 112 on the average.

Moths encased on gauze sleeves on apple tree branches or in a laboratory cage for a determination of their actual fecundity very rarely and reluctantly (as distinct from other tortrix species) laid eggs, and then usually not on bark, but on the better-lit sites — the gauze, cage wall, paper, and so on. The actual fecundity determined in this way for the hawthorn tortrix was much less than its potential fecundity and amounted on the average to 48 eggs.

Egg laying in the field (the start was recorded on July 15) continued throughout the whole period of the moths' flight. The preferred sites for egg laying were folds or crevices in the bark, usually in the forks of either the main branches or the foliage branches.

Most of the egg batches (80-100%) were situated at a height of 1 to 3 m. A small percentage of egg batches (2.4-8.9%) were noted in the top layer of the crown, at a height of more than 3 m.

On wild deciduous trees (bird-cherry, lime, aspen, maple, alder, hawthorn, etc.) in woods and parks we found egg batches of the hawthorn tortrix at a height of 7-8 m.

Special features of the egg-laying instinct (oviposition on rough bark at a preferred height of 1-3 m) probably explains why the female hawthorn tortrix does not lay eggs on young 3- to 5-year-old trees of apple, pear, plum and cherry.

The degree of infestation of apple trees of fruit-bearing age in different orchards was very high. For instance, in autumn 1955 in the Michurin Orchard of the Timiryazev Agricultural Academy 89.8% of the trees were infested with egg batches of the hawthorn tortrix, the mean density being 5.8 batches per tree. On the "Otradnoe" training farm of the same Academy 80% of the trees were affected, the average number of batches per tree being 3.2.

We noticed a mass occurrence of the hawthorn tortrix in the grounds of the L. N. Tolstoi Garden Museum "Yasnaya Polyana," where several hundreds of hawthorn tortrix eggs were counted on each lime tree in 1955.

The low temperatures of the winter 1955/56 (− 35 to − 38°C) were disastrous for hawthorn tortrix eggs overwintering above the snow cover, and in consequence larvae emerged from only a few egg batches in spring 1956.

Among the parasites of the hawthorn tortrix we noted the ichneumon Epiuris brevicornis Grav. (identified by G. A. Viktorov) and tachinids. They were of rare occurrence and were of no significance as regards reducing the numbers of the hawthorn tortrix.

Birds constitute a more important enemy of the hawthorn tortrix by destroying the egg batches, which are clearly visible like spots of lime. A particularly large number of egg batches pecked by birds were found in the orchard of the "Pamyat' Il'icha" Collective Farm in Mytishchi District of Moscow Region, where special measures are taken to attract birds to the orchard and to conserve them.

We conducted tests of the effectiveness of oil emulsions against the wintering eggs of the hawthorn tortrix. The results obtained are given in the table.

The high resistance of the eggs of the hawthorn tortrix to oils is due to the fact that the waxy substance covering the eggs does not dissolve in the oils.

SUMMARY

Eleven species of tortrices were discovered in the apple orchards of Moscow Region. The least study has been devoted to the hawthorn tortrix, which was widely distributed in the orchards and woods of the nonchernozem zone during 1953-1955.

In the central zone the hawthorn tortrix has one generation in the year. The caterpillars begin to hatch from the overwintered eggs at the time of elongation-separation of the apple buds. The injurious, caterpillar stage lasts 50 days, and the pupal stage 10-12 days.

The moths are active at twilight and during the night and are readily attracted to bait. Their flight lasts about a month. Two to four days after emergence the female moths begin to lay. Most of the egg batches are placed in folds or crevices in the bark in forks of the tree, at a height of 1 to 3 m.

A test of oil emulsions against wintering eggs of the hawthorn tortrix showed that machine oil emulsion, even in 8% concentration, was not very effective in reducing the hatch of caterpillars (the hatch was 34.3% smaller than in the control). Carbolineum in concentrations 6-8-10% had even less effect (effectiveness 7.0-9.2%).

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METHODS IN QUANTITATIVE SAMPLING OF BLOODSUCKING MOSQUITOES (DIPTERA, CULICIDAE)

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Existing methods of quantitative sampling of mosquitoes are in need of review and refinement. This is especially important at the present time in connection with the application of preparations of DDT and GBH for the treatment of buildings and herbaceous vegetation.

According to existing instructions, with a large number of mosquitoes in a building where it is impossible to capture all of them, the mosquitoes are caught into a test tube for a period of 40 minutes. But the number caught during this time does not reflect their actual numbers. For this reason there arose the question of the application of a method of sampling mosquitoes on fixed areas of surface in buildings. With this aim we adopted, in 1947, a gauze cage with a wire frame, 20 × 20 × 20 cm in size.

Comparative catches of mosquitoes with test tube and gauze cage in the course of 30 minutes indicated a great difference in the numbers of mosquitoes collected with the aid of these devices (Fig. 1).

The cate is brought up with the opening toward the surface on which the mosquitoes are resting, applied to them and then removed with an aspirator, counted and transferred into another cage.

Twenty-five samples with a cage having an area of 400 cm^2 clears out an area of 1 m^2. Time spent in the catching is not taken into account. Catching of mosquitoes with a cage on adjacent areas is not recommended as they scatter at the moment the cage is applied.

Mosquitoes in different types of buildings and on different parts of surfaces inside the buildings are not distributed evenly, which is a result of different conditions of the microclimate. The influence of microclimate on distribution of mosquitoes in shelters was studied by Beklemishev and Mitrofanova (1933). According to their opinion relative humidity is of decisive significance.

In our observations of microclimate it was found that wind and light are decisive influences on the distribution of mosquitoes inside of buildings.

Example 1. Buildings for cattle. August 27, 1957, 3 p.m. Rice storage in the bottom lands of central Zerafshan. Aperture of an open window a distance of 0.4 m from the ceiling. Air temperature near the window 31.5°C, relative humidity 26%, wind speed 0.38 m/sec. On the cane ceiling opposite the window on an area of 1 m^2 were perched 10 inactive male Anopheles maculipennis sacharovi Fv. In the corner of the side wall and celing the air temperature was 31 degrees, relative humidity 31%, and air speed 0.1 m/sec. On an area of 1 m^2 there were counted 970 mosquitoes, A. mac. sacharovi, which were very active. In this example wind had a decisive significance.

Example 2. A field laboratory building with large windows, well lighted and protected from wind. July 29, 1947, 3 p.m. The same locality. On the surface of a table the air temperature was 28°C, relative humidity 34%, wind speed 0.12 m/sec. Under the table the air temperature was 28°, relative humidity 34% and wind speed 0.12 m/sec. The mosquitoes A. mac. sacharovi were perched in shaded places: under the tables on the lower surfaces of the boards, in the space between a brick stove and a wall, in a corner behind a cabinet and under a bed. In this example light had a decisive significance.

With a wind speed of 3-3.5 m/sec the number of mosquitoes perched on surfaces in buildings diminished

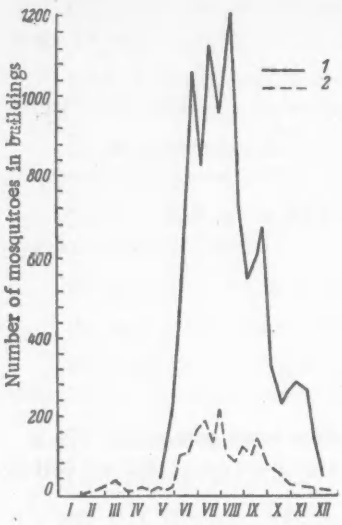

Fig. 1. Annual progression in numbers of A. maculipennis sacharovi in barns. Rice storage in bottom lands of central Zerafshan, 1947: 1) catch with cages; 2) catch with test tubes.

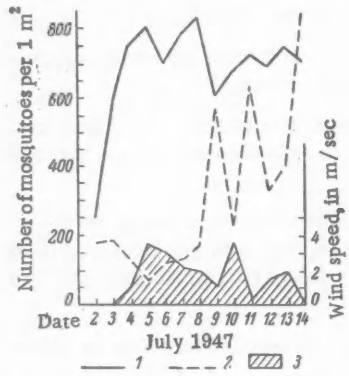

Fig. 2. Progression in numbers of A. maculipennis sacharovi in barns during the first half of July 1947. Rice storage in the bottom lands of central Zerafshan: 1) sampled with cages; 2) sampled with squares; 3) wind speed.

sharply as they were driven into sheltered places – slit-like spaces in overlapping cane-branches of the ceiling.

Quantitative sampling of the mosquitoes A. mac. sacharovi on ceiling canes of buildings during wind and during an absence of wind, with the aid of a gauze cage with an area of 400 cm^2 and simultaneously a wire square also with an area of 400 cm^2, produced the following results.

In the application of the cage to the surface of the ceiling the mosquitoes, flying out of the sheltered places where they rested, were easily removed with the cage even during windy weather, producing a significant number in the catches. But during a wind, when they were sampled with a wire square carefully brought up to the ceiling, the counts of mosquitoes visible to the eye always produced lower figures (Fig. 2).

Method of Sampling Mosquitoes in Buildings

Bottom lands of central Zerafshan. Rice storage. Building for cattle. Area of ceiling 5.76 m^2. July 10, 1947, 3 p.m. No wind. The mosquitoes A. mac. sacharovi were sampled with a gauze cage on the cane-branch ceiling, on the surface of a pile of straw on the floor, and on the adobe walls (Table 1).

In this building there was only one passage for a door. Areas closer to the door were more lighted and wind-blown, and for this reason were less populated by mosquitoes than the areas farther from the door. There were comparatively few mosquitoes on the straw. On the walls the mosquitoes rested at the base of the ceiling. On all surfaces of the building 2053 A. mac. sacharovi mosquitoes were counted.

The surfaces inside the buildings were differently constructed. In some cases they were uneven and step-like. To this type belong ceilings covered with brushwood, canes, Berdan pan, sticks and girders which have spaces in the form of slits, and openings in fissures of Berdan, through which the mosquitoes filter. In other cases the surfaces are smooth and without cracks, for example plastered ceilings and walls and plywood ceilings. On the uneven cane-branch surfaces the mosquitoes are not completely removed. (Table 2).

With a cane-branch ceiling the first application of the cage removes 65%, with a plank or stick surface where there are cracks, 90-95%, and with a plastered surface without cracks it removes all the mosquitoes. Consequently there should be introduced into the figure of 1699 mosquitoes, taken from the cane ceiling of a building (Table 1), a correction of 35% which consists of 595 mosquitoes and results in a total of 2294 mosquitoes. But this figure too, is only an approximation, as part of the mosquitoes in the closed refuges of the cane-branch ceiling remained uncounted. A complete count is obtained only through observations of their exits from the building through the door opening. For this purpose the door is draped with gauze and all other openings are closed and sealed. The observer who is inside the building, removes with an aspirator the mosquitoes settling on the gauze in their attempt to fly out. At night the building is lighted by a "Bat" lamp.

Counts of circling mosquitoes in the buildings are conducted by two observers. One of them stays outside and catches the mosquitoes on the gauze at the door "on entrance" and the other, as stated, catches them "on exit."

TABLE 1

1. Count of Mosquitoes on the Surface of the Ceiling

Wall with door in corners under the ceiling					Wall opposite the door					Area opposite the side walls; no. of mosquitoes on $1 m^2$	The mean on $1 m^2$	Total counted on the ceiling
no. of plot	temperature	humidity	wind speed (in m/sec)	no. of mosquitoes on $1 m^2$	no. of plot	temperature	humidity	wind speed (in ml/sec)	no. of mosquitoes on $1 m^2$			
1	–	–	–	173	3	29°	32%	0.12	336	–	–	–
2	30°	37%	0.25	227	4	29.5°	32%	0.12	424	315	295	1699

Note. The arithmetic mean was computed from the sum of five components: 173, 327, 336, 424, and 315 = 1474, and 1699 by multiplying 295 by 5.76 (the area of the ceiling).

2. Count of Mosquitoes on the Surface of Walls and Pile of Straw

Wall with door on the surface of the straw					Wall opposite the door					On the surface		
no. of plot	temperature	humidity	wind speed (in m/sec)	no. of mosquitoes on $1 m^2$	no. of plot	temperature	humidity	wind speed (in m/sec)	no. of mosquitoes on $1 m^2$	walls	pile of straw	ceiling, walls, and straw
1	–	–	–	21	3	–	–	–	63	–	–	–
2	27.5°	38%	0.36	38	4	27°	38%	0.18	76	153	201	2053

Note. The figure of 2053 mosquitoes consists of the figures 1699, 152, and 201.

Catches of mosquitoes on the surfaces of ceilings and walls in buildings and their catches "on exit" at the door opening of buildings indicated large differences in the number of mosquitoes counted (Fig. 3).

However, a complete count of mosquitoes is not obtained with just a single "on exit" observation – part of them remain in the building, digesting blood. A complete catch is obtained only with several successive counts (with the door openings draped). On August 25, 1953 a catch on surfaces in a building produced 193 A. mac. sacharovi, and "on exit" on the night of August 25-26 392, on the night of August 26-27 116, on the night of August 27-28 43, and on the night of August 28-29 0. There was a total of 748 mosquitoes in the building. The catch on surfaces with an aspirator produced 25%. The flight during the first night produced more than 50%.

A complete count is not obtained with the common cone-shaped mosquito trap with a narrow entrance opening (the size of a five-cent coin). In the worked-over buildings they proved completely ineffective.

With a small number of mosquitoes permitting a complete catch, counts cannot be limited only to mosquitoes caught on surfaces with the aid of an aspirator, as the largest part of the mosquitoes are concentrated in spaces in the cane-branch ceilings. Various means are employed in driving them out of these refuges: striking the ceiling with a stick, fumigating with neutral smoke, and for the counts: observations "on exit" at the door opening.

On high ceilings squares of 0.04 m^2 (400 cm^2), 0.25 m^2 and 1 m^2 are measured by means of visual estimates, according to the level of mosquito abundance permitting the possibility of counting them on these squares. When the points of these squares are touched with the end of a stick the mosquitoes fly off their resting place and are counted at the moment of flight.

Mosquitoes populating piles of brushwood, grass, straw, rags and wool on the floor, lower surfaces of tables, chairs, stools, beds, on recesses of walls with bales of blankets and domestic utensils, corners behind stoves,

TABLE 2

Counts of the Mosquito Anopheles maculipennis sacharovi Fv. on Different Types of Surfaces

Type of building and its surface	Date of count	No. of plot	Ordinal number of sample on an area of 400 m² (number of mosquitoes)				Total
			1st	2nd	3rd	4th	
Barn. Cane-branch ceiling	October 6, 1949, 10 a.m., no wind	1	8	3	1	0	12
		2	7	4	0	0	11
	Total		15	7	1	0	23
Shed. Board ceiling Cracks	October 6, 1949, 10:15 a.m., no wind	1	12	1	0	0	13
		2	1				1
		3	17	1	0	0	18
		4	8	0	0	0	8
	Total		38	2	0	0	40
Native house (nomad tent). Ceiling of sticks. Cracks	October 6, 1949, 10:30 a.m., no wind	1	21	1	0	0	22
		2	3	1	0	0	4
	Total		24	2	0	0	26
Same. Wall plastered (recessed). No cracks	June 21, 1947, 2 p.m., no wind	1	21	0	0	0	21
		2	17	0	0	0	17
		3	13	0	0	0	13
	Total		51	0	0	0	51

cabinets, boxes, trunks, sacks, etc., are caught with aspirators or cages, depending on the circumstances.

In buildings treated with preparations of DDT the same methods of inspection are employed as in untreated ones with a small number of mosquitoes. An important consideration in this is the time of day for conducting the count, as the number of mosquitoes in a building treated with DDT in summer changes sharply in the course of a day. At night the mosquitoes fly into such buildings with the same intensity as in the untreated ones, but they die in them at the end of the day from the action of the DDT.

Example. In a building for cattle, surrounded by rice-fields, on August 1, 1949 at 5:30 a.m. during sunrise. 88 A. mac. sacharovi were counted visually, at 10 a.m. 10, and at 6 p.m. only 1 mosquito. Thus, in the summertime mosquitoes in treated buildings should be counted from 9 a.m. to 3 p.m.

Distribution of Mosquitoes in Vegetation and Methods of Sampling Them

In vegetation mosquitoes are capable of migrating in the course of a day (Beklemishev, 1934). Mitrofanova (1946), attaching great significance to moisture in vegetation for A. hyrcanus Pall. and A. pulcherrimus Theo., noted also the influence of wind on the character of their distribution in vegetation.

According to our observations the decisive influences on the character of mosquito distribution in vegetation are exerted by wind and light.

Example 1. Leaves of potato plants. August 1, 1947, 11 a.m.

a) At the lower parts of the stems of the plants the air temperature was 24°, relative humidity 55%, and

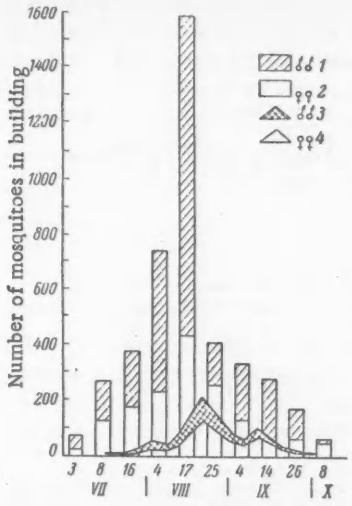

Fig. 3. Seasonal progression in the numbers of A. superpictus in the bottom lands of the upper reaches of the Surkhan-Daria and Uzun rivers in 1933: 1) catch of males "on exit" from building; 2) same for females; 3) catch of males on surfaces in the same building; 4) same for females.

air speed 0.31 m/sec. The mosquitoes Aëdes caspius Pall. and Culex modestus Fic. were on the lower surfaces of the leaves.

b) Top of the stems and leaves. Air temperature 23°, relative humidity 55%, wind speed 1.25 m/sec. The mosquitoes, because of the wind and light, were absent here.

Example 2. Lower storey of herbaceous vegetation in overgrown reeds. August 2, 1947, 3 p.m.

a) At the lower parts of the stems of the plants (3-5 cm from the soil) the air temperature was 28°C, relative humidity 58%, wind speed 0.15 m/sec. Shaded. On stems and leaves rested the mosquitoes Aëdes caspius Pall., Culex modestus Fic. and C. pipiens L.

b) Stems and branches with leaves at a height of 0.3 m from the soil. Air temperature 29°, relative humidity 54%, wind speed 0.4 m/sec. Illumination quite intense. No mosquitoes.

c) Top of the stems of the plants at a height of 0.65 m from the soil. Air temperature 30.5°, relative humidity 49%, wind speed 1.75 m/sec. No mosquitoes.

In the summertime the mosquitoes rest on the lower parts of the stems of herbaceous vegetation by day. On still evenings 1-1½ hours before sunset they move upward along the stems and branches. At sunset the mosquitoes leave the tops of the stems and fly in the open air. In the morning after the night flight the mosquitoes again settle on the plants, flying from one to another, and with the warming by the rays of the rising sun they move along the stems from the top to the lower parts of the stems, where the wind and bright light are absent.

The following vegetation has been established as a diurnal place of refuge for exophilous mosquitoes: shrubs, reeds, corn, sorghum, lucern, rice in the threshing stage, cotton plants, carrots and other melon and vegetable crops. In addition to vegetation the mosquitoes populate abandoned wells, holes, hollows, spaces under bridges, cornices, etc.

Mosquitoes are observed in largest numbers in tall and dense grass fields, especially in places where cattle breed and pasture. In low and thinned vegetation there are few mosquitoes.

In reeds, corn, sorghum, shrubs, and flower gardens, the mosquitoes are distributed in the lower storey of herbaceous vegetation. After weeds are hoed out of the corn and sorghum mosquitoes are not usually observed. Mosquitoes do not occur in the crown of tall trees, especially in those growing singly, in rice fields in the sprouting stage of the rice and in the threshing stage during the waxy ripeness. Mosquitoes are rare in rice fields during cutting time.

In spring mosquitoes in vegetation are rare. In the autumn, when the rural-economic crops are harvested, mosquitoes remain only in wild-growing herbaceous vegetation, where they overwinter.

In herbaceous vegetation mosquitoes are usually caught with an entomological sweep-net which has, however, substantial disadvantages. In catches with it, accuracy is not attained in counts of mosquitoes on a definite area of vegetation, and difficulties arise during their extraction from the net and transference into a jar.

In 1944, in order to avoid these disadvantages and inconveniences, we substituted cloth cages for the sweep-net. With a cage it is possible to count mosquitoes on definite areas of vegetation, and no difficulties arise during the extraction of mosquitoes. The frame of the cage is made of wood strips and measures 0.5 x 0.5 m at the base, with an area of 0.25 m^2 and is 0.75 m tall. The inside of the frame is lined with gauze. One end remains open. The open end of the cage is plunged into a thicket of herbage. Then the lower parts of the plant stems beneath it are beaten with a stick, and the mosquitoes fly into the cage. The same effect is obtained when

TABLE 3

Counts of Mosquitoes with Repeated Extractions from Vegetation in an Area of 0.25 m^2

Date	Time of extraction	Weather conditions	Plant community	No. of plot	Counts 1st	2nd	3rd	4th	Total
					number of mosquitoes				
25 VIII 1949	18 hr	Still	Rice field	1	7	2	1	0	10
8 IX 1949	18 hr	"	Rice field	1	1	1	0	0	2
			Same "	2	1	0	1	0	2
				3	2	1	0	1	4
14 IX 1949	18 hr	"	Rice field	1	6	1	7	0	14
			Same "	2	7	2	3	1	13
				3	5	1	0	0	6
			Total	—	30	8	12	2	52

the cage is shaken from side to side in the vegetation. After this the cage is turned over, placed on the ground, the open end quickly covered with a piece of material and the mosquitoes in the cage under it are extracted with an aspirator. On an area of 1 m^2 the cage is applied 4 times.

A single application of the cage to vegetation does not secure a complete catch of the mosquitoes — part of them remain in the vegetation. These remaining mosquitoes are removed only with successive extractions from the same area of vegetation (Table 3).

The cage is employed for catching mosquitoes in vegetation not taller than 1 m. For catching mosquitoes in vegetation taller than 1 m (reeds, shrubs, etc.) a canopy is used which is draped on the tops of the stems and on sticks stuck into the ground. The mosquitoes fly under the canopy when the stems of herbaceous plants of the lower storey are beaten with a stick.

Results of the mosquito catches depend on the time of day. In the summertime the most advantageous time for catching mosquitoes in vegetation is during still evenings before sunset and in the early morning hours. However, it is inconvenient to catch mosquitoes in vegetation in the morning because of the dew. In the summer, in thickets and reeds, mosquitoes may be caught also during the daylight hours.

In autumn, when the nocturnal temperature is below the threshold of activity of the mosquitoes, they fly during the day. At this time it is more convenient to conduct catches of mosquitoes in herbaceous vegetation during the second half of the day.

Methods of Sampling Mosquitoes Attacking in the Open Air

For counting mosquitoes attacking humans in natural conditions, the following means are used. With one of them the mosquitoes are sampled with the aid of a cloth "bell" (Monchadskii and Radzivilovskaya, 1947) and a "curtain bell" (Chagin). With another the mosquitoes are sampled with the aid of an ordinary canopy.

The bell (1.6 x 1.9m) is cumbersome, which impedes its transport from place to place, and in addition, in many places where there are no trees the possibility of its use is limited. The curtain bell is not hung up but is set up on a stand (on the ground), which allows the possibility of its use in treeless regions. But it is likewise cumbersome (1.4 x 2 m) and is not very portable. In this respect the canopy has an advantage — it is very portable and may be used in any conditions. The canopy is the most practicable device for observing attacking mosquitoes in enclosures.

In each case the lure for the mosquitoes is a human. In sampling with the bell the mosquitoes flying around it and those attacking are separated from the surrounding space at the moment that the bell is lowered to the ground, where a person is found who removes the mosquitoes inside the bell in the course of a few minutes. Mosquitoes may be sampled with the bell at any frequency, but pauses for collecting the mosquitoes are unavoidable.

Under the canopy the mosquitoes fly in through the one side which remains open in the course of the entire

observation time and they are removed without interruption, and usually after an hour interval they are transferred into a separate cage. In this way, with an uninterrupted extraction of mosquitoes under a canopy a more complete count is obtained than with a bell, which is important with a small number of attacking mosquitoes. With a large number of mosquitoes, when the observer is unable to cope with their extraction, the open side of the canopy is lowered, and at the end of the extraction the canopy is again opened.

Because of its simplicity of application, a series of simultaneous observations can be easily secured under the canopy.

SUMMARY

1. For sampling mosquitoes in buildings with a large number of mosquitoes where a complete catch is not possible, a gauze cage measuring 20 x 20 x 20 cm is employed.

2. In buildings with a small number of mosquitoes, permitting a complete catch, the catching should not be limited only to the surfaces of the cane-branch ceilings, as the largest part of the mosquitoes remain in depressions of the ceiling. For driving them out of there, fumigation and knocking on the ceiling is employed and observations are made "on exit" at the door opening.

3. In buildings treated with DDT the same methods of counting mosquitoes are employed as in untreated buildings with small numbers. Checking of buildings is recommended from 9 a.m. to 3 p.m.

4. Sampling of mosquitoes is not recommended during strong winds, as they are driven into sheltered refuges in ceilings and other shelters.

5. Counts of mosquitoes in herbaceous vegetation less than 1 m in height are conducted with cages measuring 0.5 x 0.5 m at the base and 0.75 m tall.

6. Counts of mosquitoes in herbaceous vegetation higher than 1 m are conducted with canopies draped over tops of stems and sticks stuck into the ground.

7. In the summertime sampling of mosquitoes in vegetation is recommended in the evening before sunset, when there is no wind.

8. In the autumn mosquitoes in vegetation are sampled during the second half of the day.

9. For counts of attacking mosquitoes in natural conditions the bell and canopy are used.

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LIGHT-TRAPS AS A METHOD OF COLLECTING AND STUDYING INSECTS CARRYING DISEASE

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Many bloodsucking diptera which carry diseases are active not only during daylight, but also during the dark part of the day. Some of them, as for example gnats (Phlebotomus) and most of the heleids of the genus Culicoides, attack their prey predominantly at the onset of dusk. Crepuscular and nocturnal insects react decidedly to light and are capable of becoming attracted to a variety of its sources. This peculiarity has been used for a long time in collecting them. Even in 1867 catching on lights was known in Russia as a usual means of collecting nocturnal moths (Gyuber, 1867). At that time kerosene lamps served this purpose. With the spread of electric lamps, especially as a source of ultraviolet rays, catching of insects with light became widely employed. In 1932 Headlee (Headlee, 1945) constructed a trap in which insects, attracted to a light source, were drawn with a fan into a can where they were killed with cyanide. A 25 watt electric lamp served as a light source. Subsequently gas generator lamps were likewise used in the traps. Such traps found wide application in the USA and other foreign countries for studying various insects, among them mosquitoes (Culicidae) and heleids of the genus Culicoides (Thurman and Thurman, 1955; Beck, 1958; Fox, 1958).

In USSR traps of similar construction were first employed by Mazokhin-Porshnyakov 1955, 1956. For a light source he used PRK-2 and PRK-4 lamps which radiate many ultraviolet rays that attract insects most strongly. In the experiments of Breeva, 1958, light traps indicated good results in collecting mosquitoes. He employed them on the Volga delta, where the numbers of these bloodsuckers are exceptionally great, and the high temperature favors massive flights of them in the evening hours.

Pogodina and Saf'yanova (1957) tested light trapping in the central zone of RSFSR and found that bloodsucking diptera were extremely weakly attracted to ultraviolet rays. But they could not fully take into account the attracting action of ultraviolet on the insects, as they used a trap that did not have an aspirator and for this reason it caught only a small part of the bloodsucking diptera attracted by the light. These traps, as the experiments of Breeva and our observations show, produce catches hundreds of times smaller than traps with a suction apparatus.

We set out with the aim of testing the performance of light traps in regions where numbers of bloodsucking diptera are relatively small. In such circumstances collection of the quarry requires a great deal of time and does not permit an adequate disclosure of the species composition and the numerical relationships of the species of bloodsuckers because not all of them attack man with the same inclination. In such regions it is especially difficult to obtain males, which are necessary for accurate species determinations.

The work was conducted in the summer season of 1958 in the Zakarpat and Ternopol' District of Ukrainian SSR and in the Ashkhabad District of Turkmenian SSR. In these regions studies of bloodsucking diptera have great practical significance, as they are carriers of disease organisms of man. In Zakarpat and Prikarpat there were isolated from some species of mosquitoes several strains of neurotropic virus belonging to the lymphocytic – choriomeningitis group (Glushchenko, Gytsevich and Dudkina, 1957). In the contingent regions of Czechoslovakia, there is found a natural center for the American equine encephalomyelitis of the western type (Libikova, 1954), a virus that is transmitted by mosquitos. In the Tedzhen Region of the

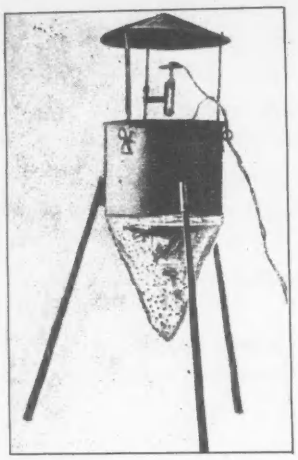

Fig. 1. Trap with a fan and PRK-4 lamp.

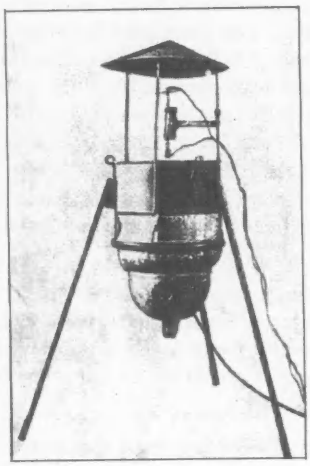

Fig. 2. Trap with a vacuum cleaner and PRK-4 lamp.

Ashkhabad District there was observed, in 1958, among construction workers a great number of cases of skin leishmaniosis, the carriers of which, as is well known, are gnats.

In the Zakarpat District from June 14 to July 12, 1958, the bloodsucking diptera fauna of deciduous forests was studied: on the Zakarpat plains with a predominance of oak (in the vicinity of the city of Mukachev), beech forests of the foot hills (Sinyak village) and coniferous spruce-silver fir forests of the Karpat mountains (Mezhgor'e village, 700 m above sea level). In the Ternopol' district bloodsuckers were caught from July 16 to 25, 1958 in the white beech forests in the region of Terebovloi village. In Turkmenian SSR collecting with traps was conducted from August 23 to September 12, 1958 in the city of Tedzhen and its vicinity in the conditions of an open semidesert type of landscape.

A somewhat simplified and lighter model trap, adapted by Mazokhin-Porshnyakov (1958) (Fig. 1), was used. The body of such a trap consists of a tin cylinder 30 cm in diameter and 25 cm tall. Over the cylinder a roof is attached on stands, providing protection from the rain. To one of the stands there is also attached with a bracket a PRK-4 lamp which is placed vertically over the center of the cylinder. Inside the body of the trap there is enclosed a desk type of fan with rubber blades. Its power is 75 watts, with 1500 revolutions per minute. On the lower end of the body, with the aid of a rubber band, a double gauze bag is attached which serves as a receptacle. Insects attracted to the light are carried into the receptacle by the air stream that is created by the fan. The trap is mounted on legs so that the lamp is exactly 1.5 m from the ground. Placement of the trap at a greater height did not increase the catches.

Tested also was the trap of original construction in which a vacuum cleaner was used for drawing in the insects (Fig. 2).

Serving chiefly in the work was a trap with a PRK-4 lamp. In comparative tests run simultaneously with it a trap with other sources of light was included. In such capacities were tested a PRK-4 lamp with a UFS-3 filter, 200 and 400 watt electric lamps, and also electric lamps of red and of dark blue glass. The duration of a single sampling with a trap was, as a rule, 30 minutes. The best time for collecting with light proved to be the hours from onset of darkness to midnight. Besides collecting with traps, 20-minute collections of bloodsucking diptera on man were conducted during daylight with test tubes and aspirators, and during the functioning of the traps — with a bell modified by Yu. A. Berezantseva.

Light traps proved to be suitable for collecting heleids, mosquitoes and gnats. Tabanids and midges very rarely got into them in our tests.

The use of light traps produced particularly good results in collecting heleids, which are strongly attracted to artificial light (Gutsevich, 1956). In the Zakarpat and Ternopol' Districts very few of them were obtained by the usual means — sampling with bells and test tubes on man. For several hundred samplings less than one hundred heleids were collected. Such collections were particularly poor in flat places. In the Tedzhen Region these means failed to obtain a single heleid.

Light traps gave entirely different results (Table 1). For 200 samples more than 42,000 heleids were collected. In the forests of west Ukraine, and in conditions of open landscape in Central Asia, collections with traps produced, as a rule, hundreds and thousands of times more heleids than the usual means of obtaining them. Owing to the use of light traps the presence of heleids in the Tedzhen Region of Turkmenian SSR and their very great numbers in the forests of the Zakarpat lowlands and Ternopol' District was established.

TABLE 1

Number of Heleids in Collections with Light Traps

	Deciduous forest with predominance of oak, plains (Mykachev region	Beech forest, foothills (Sinyak village region)	Coniferous forest, mountains (Mezhgore village region)	White-beech forest, plains (Terebovloi village region)	City of Tedzhen and its vicinity, semi-desert
Total heleids collected	11300	2141	110	27500	1135
Mean size of collection for 30 minutes	153	214	11	500	22
Maximum collection	1280	697	17	6850 (for 15 minutes)	199

TABLE 2

Species Composition of Heleids (Culicoides) in Collections with Light Traps with a PRK-4 Lamp in West Ukraine

	Oak forest, plains	Beech forest, foothills	Coniferous forest, mountains	White-beech forest plains		Oak forest, plains	Beech forest, foothills	Coniferous forest, mountains	White-beech forest, plains
Culicoides nubeculosus Mg. . .	—	—	—	+	*C simulator* Edw.	+	+	—	—
C. circumscriptus Kieff.	—	—	—	+	*C. fascipennis* Staeg.	+	+	+	+
C. salinarius Kieff.	+	—	—	+	*C. achrayi* Ket. Law.	—	+	+	+
C. pulicaris L. .	+	+	—	+	*C. pallidicornis* Kieff. . . .	+	+	—	—
C. obsoletus Mg.	+	+	+	+	*C. cubitalis* Edw.	—	+	+	+
C. scoticus Dow. Ket.	—	+	—	+	*C. subfascipennis* Kieff.	+	+	—	+
C. chiopterus Mg.	—	—	+	—	*C. vexans* Staeg.	—	—	—	—
C. odibilis Aust.	+	+	+	+	*C. cunctans* Winn.	+	—	+	+

Knowledge of the species composition of heleids in west Ukraine is meager. A list of some species of Culicoides in the Zakarpat District is presented by Remm (1957).

Species of heleids found in collections with light are presented in Table 2.

The predominant species proved to be:

1) forest with oak predominating — C. odibilis Aust. (93%), C. pulicaris L. (4.0%);

2) beech forest — C. pulicaris L. (53%), C. obseletus Mg. (32%);

3) spruce-silver fir forest — C. obsoletus Mg. (50%), Culicoides of the fascipennis group (28%);

4) white-beech forest — C. odibilis Aust. (72%), Culicoides of the fascipennis group (9%), C. circumscriptus Kieff. (7%).

More than 50% of the material collected with light in the Ukraine consisted of males. This circumstance permitted the determination of species of Culicoides of the obsoletus and fascipennis groups. Among the latter a species new to USSR was found — C. achrayi Ket. Law., which was recently described from England (Kettle and Lawson, 1955). In the obsoletus group C. scoticus Dow. Ket., was common, previously being found in USSR only in the region of the city of Sukhumi.

In the Tedzhen Region six species of heleids were found with the aid of light traps. The most numerous

TABLE 3

Species Composition of Mosquitoes (Culicidae) in Collections with Light Traps with a PRK-4 Lamp and on Man (region of Terebovloi village)

	Number of mosquitoes collected					Number of mosquitoes collected			
	with test-tubes on man (50 samples)	with light-traps (25 samples)				with test-tubes on man (50 samples)	with light-traps (25 samples)		
		females	males	total			females	males	total
Aëdes caspius dorsalis Mg.	—	1	1	2	*Aë. cinereus* Mg.	24	13	12	25
Aë. cantans Mg.	102	35	3	38	*Aë. rossicus* D.C.M.	—		2	2
Aë. excrucians Wlk.	10	—	—	—	*Mansonia richiardii* Fic.	20	1	1	2
Aë. communis Deg.	10	1	2	3	*Culex modestus* Fic.	—	—	2	2
Aë. punctor Kirby.	—	1	—	1	*C. apicalis* Ad.	—	—	2	2
Aë. sticticus Mg.	32	10	10	20	*C. pipiens* L.	4	51	189	240
Aë. diantaeus H. D. K.	1	—	—	—	*Theobaldia alaskaensis* Ludl.	—	2	1	3
Aë. leucomelas Mg.	—	3	—	3	*Anopheles maculipennis* Mg.	10	6	1	7
Aë. vexans Mg.	126	48	38	86	*A. bifurcatus* Mg.	19	2		2
Aë. geniculatus Ol.	692	12	1	13	Total	1050	186	265	451

of them were C. schultzei End. (48%) and C. puncticollis Beck (43%). In collections from this region 15% of the heleids were males.

Still, warm evenings should be considered the most favorable times for catching heleids. After midnight the number of insects in the collections declined sharply. In west Ukraine, with an air temperature below 13° only single heleids got into the traps. In the conditions of open landscape in the vicinity of Tedzhen the greatest hindrance to the work was wind, which lowered sharply the size of catch even at the speed of 0.5 m/sec. With a wind of 0.8 m/sec heleids did not get into the traps.

Although the heleids in the regions investigated do not attack man intensively, they may nevertheless play a role in circulating various pathogenic virus in nature. The role of heleids as possible carriers of pathogenic organisms of diseases in man is brought to attention in connection with the facts of the establishment of natural contamination of these insects with the virus of Japanese encephalitis in China (Wu Chiao-ju and Wu Shu-yin, 1957) and the virus of American equine encepholomyelitis in the USA (Karstad et al., 1957). Centers of the latter sickness, as stated above, are found in Czeckoslovakia adjacent to the Zakarpat District. For this reason there is great significance in the collection, with the aid of light traps, in the regions stated, of heleids in numbers sufficient not only for species determinations but also for virological investigations.

The suitability of light traps for collecting mosquitoes is well known. This was also supported by our observations. It is true, however, that in the Ukraine collections with traps were quantitatively smaller than collections with test tubes on man during daylight hours, as the peak of mosquito flight under the conditions of the cool summer in the places of work, occurred during the light part of the day. When sampling with a bell in the period from 4 to 6 a.m. a mean of 18 mosquitoes per sample was collected, while from 9 to 11 a.m. such collections produced only single individuals of these bloodsuckers, and frequently they produced no results. The average catch with a PRK-4 lamp in the Zakarpat District consisted of 12 mosquitoes. In this district light traps revealed three species of mosquitoes, not detected by other means: Aëdes communis Deg., Aëdes deantaeus H. D. K. and Anopheles bifurcatus L. Data on mosquito fauna of Zakarpat is presented in the work of Gutsevich and Podolyan (1959). The species composition of these bloodsuckers, collected in the Terebovloi village, is indicated in Table 3. On the average fewer mosquitoes were collected per sample with light traps than with test tubes. But collections with light were richer in species, and more than half of the insects consisted of males. The numerical relationships of the species in collections made by the two methods were

TABLE 4

Comparative Collections of Gnats (Phlebotomus) Made with Sticky Paper and Light Traps with a PRK-4 Lamp

Place of collection	Number of gnats	
	average for one sticky paper for 3 minutes	average for one sample for 30 minutes
Northern border of the city	4	17
Bank of Tedzhen R. (southern border of the city)	0	3
Yard beside the city bath	0	4
New construction 6 kilometers from the city of Tedzhen	2	8
Melon fields, river bank, 16 kilometers west of the city of Tedzhen	15	96

different: Culex pipiens L. was caught almost exclusively with light and predominated in trap collections, while in collections made with test tubes more than 60% consisted of Aëdes geniculatus Ol.

In the Tedzhen Region of Turkmenian SSR, at the end of August and beginning of September, mosquito attacks on man were almost unnoted, when 166 mosquitoes were obtained with traps, mainly male Aëdes caspius caspius Pall.

The relationships of the parasite components in material collected with traps and from prey, naturally are not the same. The principal part of collections made with traps consisted of heleids, but collections from man consisted chiefly of mosquitoes. Thus, only a combination of both methods permits the most complete exposition of the species complex in bloodsucking diptera.

For collecting epidemiologically important bloodsuckers – gnats – light traps also proved to be extremely suitable. With small numbers of these insects in the region of the city of Tedzhen, the action of the traps compared with the most widespread means of collecting gnats – sheets of sticky paper. The sticky sheets were hung out in lots of 40 at various points of the city and vicinity for a period of three days. Each day, simultaneously with collection by means of sticky paper, light trapping was conducted during the first three hours after sunset. At each point not less than 18 samples were made with light traps (Table 4).

As can be seen from this table the traps permit the attainment of more complete and reliable data on the presence of gnats in places under examination. With their aid it was possible to find the bloodsuckers in places where not a single gnat had been caught on several dozen sticky papers for 3, and sometimes even for 10 days. In order to obtain objective data with the aid of sticky papers it is necessary to use large numbers of them and to spend a great deal of time. Results may differ, depending on a more or less successful choice of place for distributing the sheets of sticky paper. In open locations outside of inhabited points the sticky papers are severely contaminated with sand. Gnats obtained by this means are very poorly preserved. Light traps permit the avoidance of these disadvantages. They function in inhabited points as well as outside of them, they require little time for collecting and permit procurement of well-preserved gnats.

With the aid of light traps in the Tedzhen Region, 1500 gnats of three species were collected: Phlebotomus papatasii Scop. (96%), Ph. arpaklensis Perf. (2.8%), Ph. alexandri Sint. (1.2%).

The size of collection made with a trap depends on the light source used in it. We compared the action of PRK-4 lamps and 400 watt lamps, which give equal illumination under the same conditions. This was measured with a Weston light meter, the sensitivity of which, to different parts of the spectrum, is close to the sensitivity of the human eye. The lamps mentioned differ from one another in many ways. The spectrum of the mercury lamp is lineate, while the spectrum of the electrolamp is continuous. The amount of radiant energy and its distribution over various parts of the spectrum is also different. Close to half of the energy of the PRK-4 lamp goes into ultraviolet rays of bands A and C. A 400 watt electrolamp produces very few of these rays. The energy in the visible rays of this lamp, on the contrary, is more than double the energy of the mercury lamp in the corresponding band.

In sixteen collections made at the same time under the same conditions. 2.7 times more heleids and 20% more mosquitoes got into the trap with a PRK-4 lamp than into the other trap.

The stronger attracting action of the mercury lamp is explained by the action of ultraviolet rays. This may be demonstrated with collections of bloodsucking diptera made only in the ultraviolet part of its spectrum. The

elimination of visible rays is attained by enclosing a PRK-4 lamp in a case, the walls of which are made of special UFS-3 glass that passes only ultraviolet rays with long waves of 303-404 milimicrons.

Collections with a trap with such a light source produced an even larger number of heleids than simultaneous collections with a light without the filter. The means from 15 comparable collections consisted, respectively, of 85 and 73 heleids. Collections of mosquitoes with lamps with a filter were a little smaller than with lamps without it. It should be noted that the UFS-3 glass absorbs not only visible, but also part of the ultraviolet rays, and a part of these rays is also obstructed by the framework of the lantern. Taking this into account, it is possible to assume that the elimination of visible rays from the spectrum of a PRK-4 lamp does not diminish the collections of mosquitoes made with it.

Ordinary electric lamps, though they produced smaller collections than the mercury lamp, all proved entirely suitable for use in the traps. To exclude the wide spread opinion that a bright light may repel insects, a trap with a 25 watt electrolamp was included among the standards. Our observations in comparing the action of electrolamps of 200 and 400 watts power indicated that significantly more mosquitoes and heleids got into traps with a 400 watt electrolamp. In 13 parallel collections made in various regions of Zakarpat, 140 mosquitoes and 782 heleids were caught with a 200 watt electrolamp, but with a 400 watt electrolamp respectively 210 and 1100 of these insects were caught. Gnats were also more strongly attracted to a brighter light.

A blue light attracted bloodsuckers very well. With a blue 100 watt electrolamp the same number of them were collected as with a 200 watt lamp of white glass. The electrolamp of red glass attracted insects very poorly and proved unsuitable for use.

Traps with fans and with vacuum cleaners gave approximately equal results.

In addition to dipterous bloodsuckers more than 200 thousand other insects were collected in 196 trap collections, among which were representatives of fourteen orders.

SUMMARY

1. Light traps proved to be a convenient means of catching bloodsucking diptera. In combination with other methods they permit a faster and more complete study of species composition and numerical relationships in species of heleids, mosquitoes and gnats.

2. Collecting with light is successful when the bloodsucking diptera are sufficiently active. For this reason light traps are more effective in southern regions, where the high air temperature favors the flight of bloodsuckers in the dark part of the day.

3. Particularly good results are obtained with light traps in collecting biting midges. With such traps it is possible to obtain significant numbers of biting midges even when they cannot be found by collecting from man.

4. Bloodsucking diptera are most strongly attracted to a source of ultraviolet rays — a PRK-4 lamp with or without a UFS-3 filter.

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ON GONOTROPHIC RELATIONSHIPS WITHIN THE GENUS CULICOIDES (DIPTERA, HELEIDAE)*

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Characteristic of the lower bloodsucking Diptera is an adaptation to periodic attack on hosts whereby a single instance of ingestion and digestion of blood is sufficient for the complete development and maturation of the first follicles in each egg tube. At the same time, the second (and third) follicles almost never develop. The development of the second follicles can take place after the first batch of eggs has been laid, and then only in the case of a second ingestion of blood. This rhythmical activity connected with the ingestion and digestion of blood is characteristic of other physiological processes besides that of the development of the ovaries; it is true of the secretion of the peritrophic membrane, the activity of the Malpighian tubules, and the activity of the lubricating glands (Beklemishev, 1940, 1942; Dolmatova, 1942; Almazova, 1940; Beklemishev and Detinova, 1940; Denisova, 1940). This parallelism in the phases of digestion and follicular development has been called gonotrophic harmony (Swellengrebel, 1929). These characteristics separate the lower bloodsucking Diptera (Orthorrhapha) from the higher (Cyclorrhapha). In the latter, a single instance of blood ingestion is not sufficient for the maturation of a portion of the eggs, which takes place by the simultaneous development of several follicles in each egg tube (Beklemishev et al., 1934; Kuzina, 1942, 1950). In the Cyclorrhapha there is no strict dependence between the digestion of food and the maturation of follicles; the peritrophic membrane is secreted and the Malpighian tubules function independently of the intake of blood. Thus, gonotrophic harmony is absent in the Cyclorrhapha.

Since there are few accounts of the gonotrophic cycle in Culicoides (Molev, 1955; Amosova, 1956; Glukhova, 1956, 1958), a more detailed account available from the information at my disposal may be of interest.

The Christophers-Mer method of dividing the entire course of follicular development into five phases has been adopted in the literature (Christophers, 1911; Mer, 1936). This division is based on several indications: 1) the appearance of yolk granules in the oocyte and its invasion with yolk; 2) the relationship of the size of the oocyte (its length) to that of the whole follicle; 3) the appearance of the shape of the mature oocyte and the chorion. Actually eight phases are distinguishable, since the first phase of Christophers can be divided into three (according to Mer) and the second phase into two (Mer, 1936; Derbeneva-Ukhova, 1952). The process of digestion has been divided into seven phases by Sella (1920), as described in mosquitoes but also applicable to Culicoides. The adoption of the generally accepted divisions of the process of egg development and digestive stages was found to be possible for Culicoides, with a few modifications.

A description of the follicular development phases in Culicoides obsoletiformis Amosova** is presented below.

Phases in the Follicular Development of the Gonotrophic Cycle in Culicoides obsoletiformis Amosova

Phase I. The follicle consists of groups of undifferentiated cells; the follicular epithelium is not yet developed, — stage N_0.

*From material collected in the Suputinka Reservation in the Maritime Province in the summer of 1954.

**C. sinanoensis Tok. is closely related to or identical with this species (Arnaud, 1956).

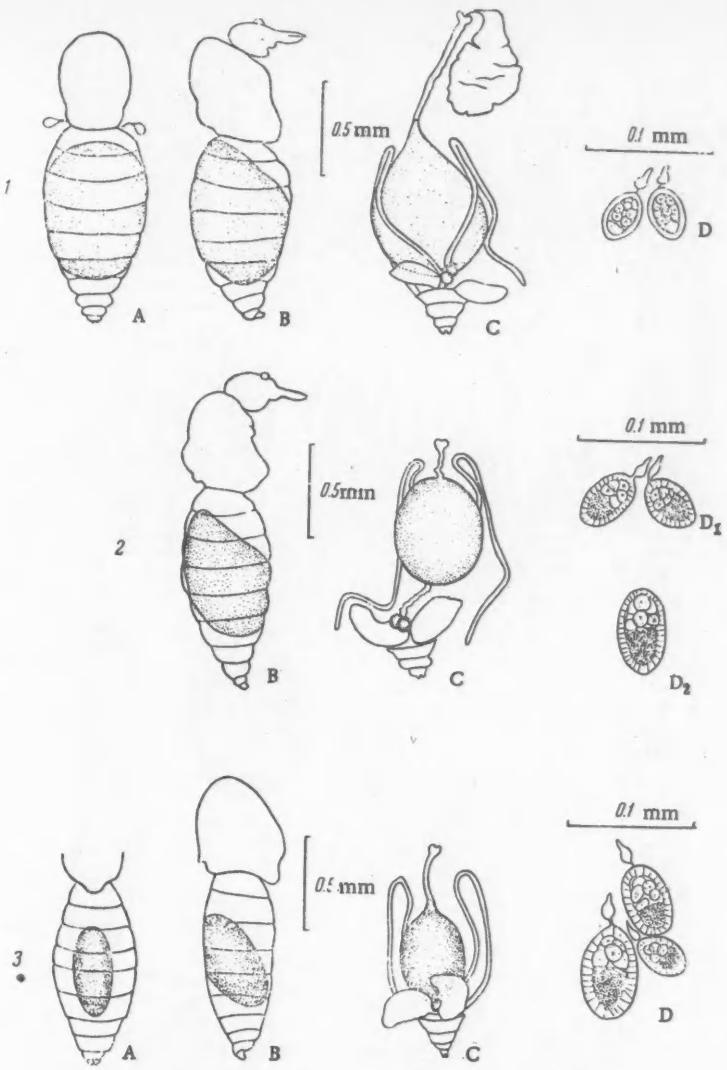

Fig. 1. Phases in the gonotrophic cycle of Culicoides obsoletiformis Amosova in dissection: A) ventral view; B) lateral view; C) extracted alimentary canal and gonads; D) follicle structure: 1) follicular phase IIA during engorgement (digestive phase 3 of Sella); 2) follicular phase IIB during engorgement (phase 3 of Sella; D_1 and D_2 in different females); 3) the same with incomplete feeding.

The follicular epithelium is developing, but the oocyte is still not distinguishable from the nurse cells; the diameter of the follicles is 0.02 mm, – stage N.

The follicle becomes somewhat oval; the oocyte is distinguishable from the nurse cells, – stage I of Mer.

Phase II. Individual yolk granules appear in the cytoplasm, the follicle measures 0.035 to 0.045 mm in diameter and 0.025 to 0.035 mm in width, stage IIA (Fig. 1, 1D).

Larger and more numerous granules appear in the cytoplasm; the egg occupies up to half the dimensions of the follicle; the nucleus of the oocyte is not visible; the follicle attains 0.05-0.07 mm in length and 0.035 to 0.04 mm in width, – IIB (Fig. 1, 2D and $2D_2$).

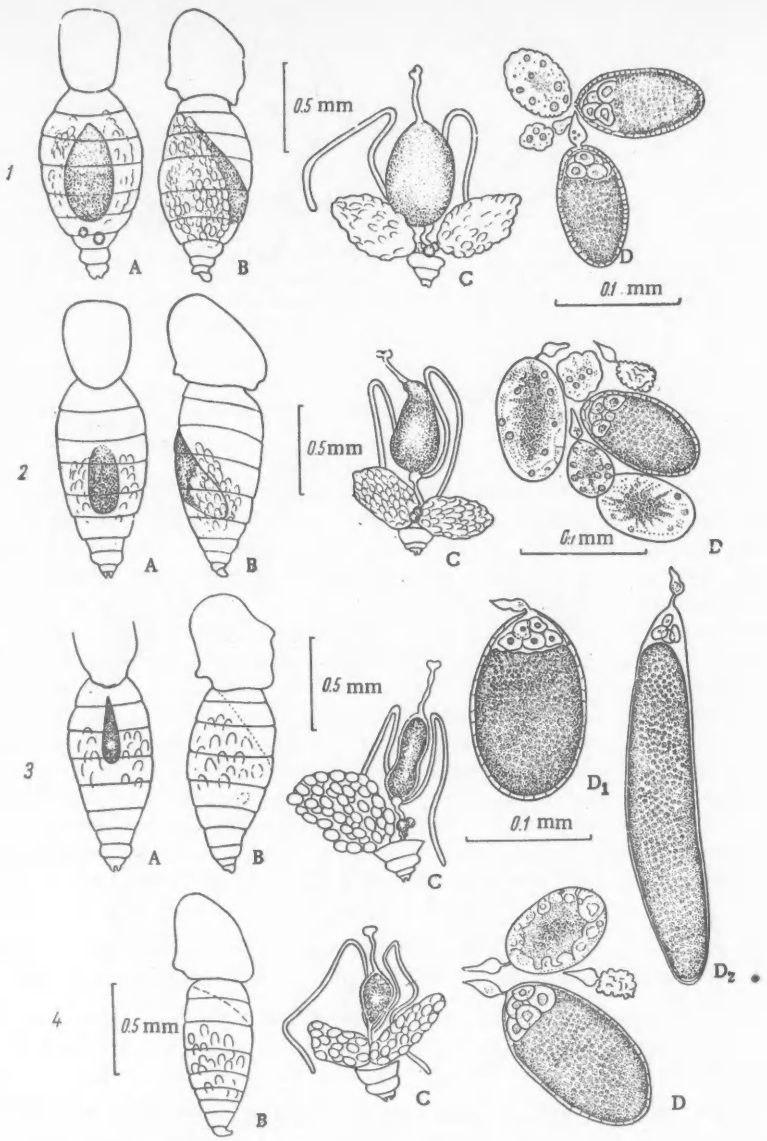

Fig. 2. Phases in the gonotrophic cycle of Culicoides obsoletiformis Amosova in dissection: A) ventral view; B) lateral view; C) extracted alimentary canal and gonads; D) follicular structure: 1) follicular phase III during engorgement (phase 4 of Sella); 2) the same with incomplete feeding; 3) follicular phase IV during engorgement (phase 5+6 of Sella; D_1 and D_2 in different females); 4) the same with incomplete feeding.

Phase III. The egg occupies 0.5 to 0.75 of the length of the follicle, which measures 0.06 to 0.135 mm in length and 0.045-0.070 mm in width (Fig. 2, 1D).

Phase IV. The oocyte occupies more than 0.75 the length of the follicle. The latter is 0.110 to 0.175 mm long and 0.06-0.09 mm wide. At the end of phase IV a change takes place in the shape of the follicle: there is a narrowing of its transverse axis and a lengthening of its longitudinal axis. The follicle becomes

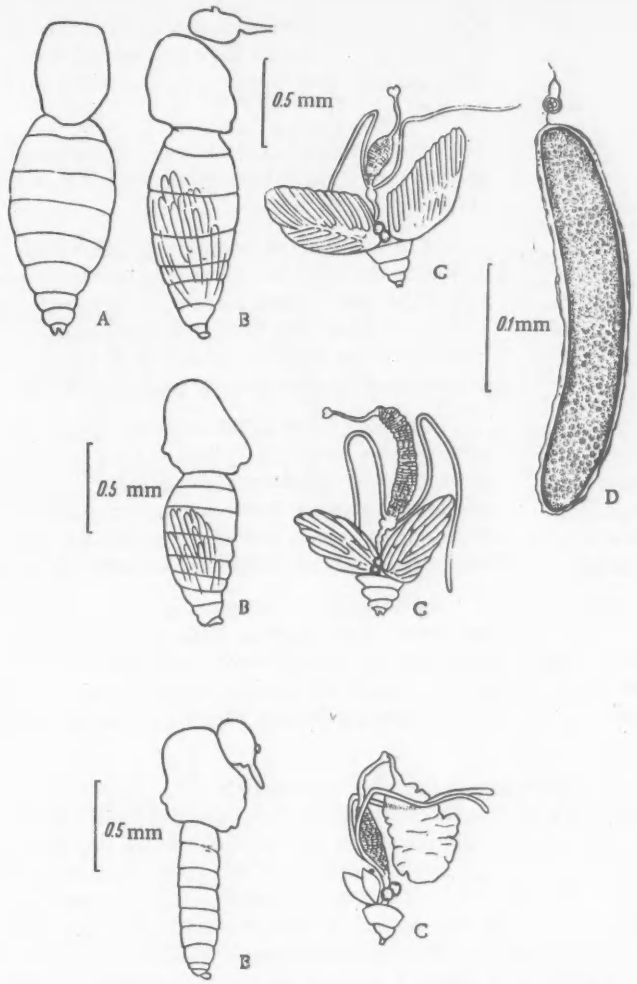

Fig. 3. Phases in the gonotrophic cycle of Culicoides obsoletiformis Amosova in dissection: A) ventral view; B) lateral view; C) extracted alimentary canal and gonads; D) follicular structure: 1) follicular phase V during engorgement (phase 7 of Sella); 2) the same with incomplete feeding; 3) female dissected after oviposition.

0.30-0.32 mm long while the width becomes 0.05-0.055 mm. The difference between this elongated follicle of phase IV and the mature follicle of phase V lies in the absence of the chorion and the presence of nurse cells (Fig. 2, $2D_1$ and $2D_2$).

Phase V. (Mature egg). The egg is cigar-shaped, slightly bent, it possesses a chorion and consequently, as distinct from the egg at the end of stage IV, it has a definite, unvarying form. Nurse cells are almost or completely absent. The length of the mature egg is 0.29-0.31 mm (mean, 0.30), the width 0.050-0.055 mm (mean, 0.052) (Fig. 3, 1D).

Thus, presented the descriptions of the phases and stages are somewhat different from the follicular development phases determined for Phlebotomus (Dolmatova, 1942) and mosquitoes (Shlenova, 1933; Beklemishev, 1944). In agreement with Mer (1936), Beklemishev divides phase II into two stages: I-II and II. In stage I-II a crown of yolk granules form around the nucleus. I did not succeed in observing this and I therefore follow

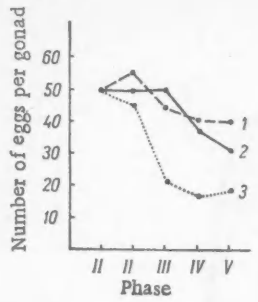

Fig. 4. Changes in the number of eggs as a result of partial degeneration under various experimental conditions in Culicoides obsoletiformis Amosova: 1) fully engorged, sugar fed; 2) fully engorged, water fed; 3) partially engorged, sugar fed.

Kuzina who, not observing such a crown of yolk granules in the stable fly and horn fly, described a stage IIA in place of the stage I-II of Mer. Stage IIA is characterized by the appearance of scattered yolk granules in the oocyte.

In Phlebotomus Dolmatova (1942) also did not observe a crown of yolk granules around the oocyte nucleus. However, she does not subdivide phase II into two stages.

I believe that the subdivision of phase II into two stages is rational. As will be described below, the follicle reaches stage IIA in the females of both of the species which I studied [C. obsoletiformis Amosova and C. pulicaris (L.)], and also in C. obsoletus (Meig.), and C. grisescens Edw., according to the data of Glukhova (1956, 1958), without the intake of blood, whereas stage IIB is achieved only after the intake of blood.

Glukhova (1956, 1958) observed a crown of yolk granules around the nucleus of the follicle in C. obsoletus and C. grisescens and proposed that phase II also be divided into a stage I-II. It seems to me that it is not advisable to divide the developmental process in too detailed a manner, especially as we know only of instances when Culicoides reached both of these stages (I-II and IIA) without the ingestion of blood.

In determining the beginning of phase IV all authors (Shlenova, 1933; Dolmatova, 1942; Kuzina, 1942; Beklemishev, 1944) point to two indications: the elongated form of the follicle and the fact that the oocyte occupies more than $^3/_4$ of the follicle. I had to throw out one of these indications since in Culicoides the oocyte already occupies 0.75 of the length of the follicle when the shape of the latter is not yet elongated and is indistinguishable from that of the preceding phase (phase III).

Dividing the food digestion process into 7 phases by Sella's system (applicable to both mosquitoes and Phlebotomus) proves to be less suitable on analysis of the Culicoides material. This system is based upon the number of abdominal segments which are filled with blood (phases 2-6) and the color of the blood (Beklemishev, Vinogradskaya, and Mitrofanova, 1934; Dolmatova, 1942). During phase 1 of Sella the gut is empty and the ovaries are not developed. In phase 2 the gut is filled with red blood, the ovaries are not developed. Two sternites and 3 tergites, or 2 full segments, are free of blood, that is to say, 6 abdominal segments are filled with blood. During phases 3, 4, 5 and 6 the midgut becomes reduced in volume from phase to phase by 1-1½ segments, such that at phase 6 it does not occupy more than two segments or contains traces of blood (Dolmatova, 1942). Thus, during phase 3 the midgut still contains much reddened blood, while during phases 4, 5 and 6 the blood has become black. During phase 7 the gut is empty and the ovaries are mature.

It is relatively easy to apply Sella's phases 1, 2 and 7 to Culicoides. Phase 3 is more difficult to distinguish, while during phases 4, 5 and 6, when the blood has become black, the midgut is situated obliquely in the abdomen of the fly to the extent that it is difficult to decide objectively how many segments are filled with blood. The number of tergites and sternites with which the gut is in contact cannot serve, also, as a good indicator because this depends on the degree of extension of the abdomen.

I do not consider it necessary to space out this period of digestion into three phases; I am dividing it into two phases which are distinguished below. In order to avoid confusion, I am designating them as phases 4 and 5 + 6 of Sella. Beside the generally adopted characteristics, I am using measurements of the midgut. Measurement was made from tracings of the abdomen in profile along the long axis of the midgut and perpendicularly.

The Digestive Phases of Sella in the Gonotrophic Cycle of Culicoides obsoletiformis Amosova

During phase 1 the midgut does not contain blood (the ovaries are not beyond stage IIA).

During phase 2 the midgut is filled with bright red, transparent blood and occupies from 5 to 6 abdominal segments. The length of the midgut is 0.75 - 0.8 mm, its width 0.45-0.65 mm (Fig. 1, 1A, 1B, 1C).

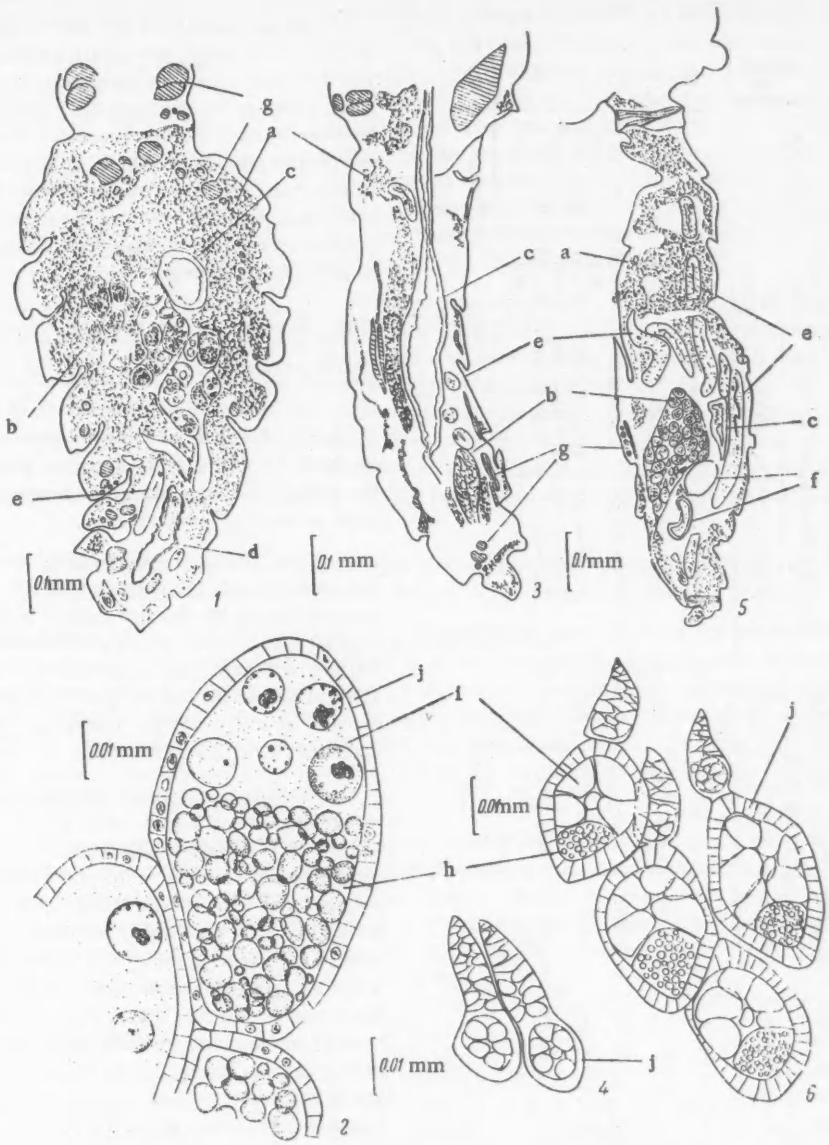

Fig. 5. Sections: 1) female Culicoides dendrophilus Amosova at the day of emergence (frontal); 2) follicles of this female; 3) female Culicoides obsoletiformis Amosova at the day of emergence (sagittal); 4) follicles of this female; 5) starved female Culicoides obsoletiformis Amosova (sagittal); 6) follicles of this female: a) fat body; b) gonads; c) midgut; d) hindgut; e) Malpighian tubules; f) spermatheca; g) muscles; h) oocyte; i) nurse cells; j) follicular cells.

During phase 3 the blood in the midgut is still bright red; the midgut occupies 4-4½ segments of the abdomen. In ventral view it can be seen that the gut reaches the sides of the abdomen (Fig. 1, 2B, 2C).

During phase 4 the blood is not transparent, the midgut is dark red in color, almost black, occupies 2½-3½ segments of the abdomen, and is now obliquely situated (Fig. 2, 1A, 1B, 1C).

TABLE 1

Gonotrophic Cycle in Fully Engorged Culicoides obsoletiformis Amosova Fed on Sugar (from dissections)

Phase of follicle development	Time elapsed since blood meal (in hours)	Digestive phase of Sella	Stomach dimensions (in mm)		Gonad dimensions (in mm)		Follicle dimensions (in mm)		Number of eggs per gonad	Mean volume of follicles	Number dissected
			length	width	length	width	length	width			
IIA . .	0—12 (4.6hr)	2 (or 1)	0.75—0.8	0.45—0.55	0.2	0.1	0.035—0.045	0.025—0.035	51—51 (51)	$18 \cdot 10^{-6}$ mm^3	15
IIB . .	12—14 (13.3)	3	0.65—0.8	0.45—0.5	0.3—0.4	0.15—0.2	0.05—0.07	0.035—0.04	45—62 (55)	$38 \cdot 10^{-6}$ mm^3	8
III . . .	30—58	4 (14 ♀) 5 + 6 (1 ♀)	0.4—0.7	0.3—0.45	—	—	0.060—0.135	0.045—0.07	34—56 (44)	$192 \cdot 10^{-6}$ mm^3	15
IV . . .	50—78 (39)	5 + 6	0.3—0.5	0.1—0.4	0.4—0.7	0.2—0.4	1) 0.11—0.17 2) 0.30—0.32	1) 0.06—0.09 2) 0.05—0.055	30—51 (40)	$393 \cdot 10^{-6}$ mm^3	13
V . . .	72 — 8-th day	7	Stomach empty		0.65—0.75	0.30—0.32	0.29—0.30	0.05—0.055	29—58 (40)	$375 \cdot 10^{-6}$ mm^3	19
										Total	70

During phase 5 + 6 the blood is opaque, the midgut is black in color, and usually occupies one to one and a half sternites; the extended anterior end of the midgut approaches one tergite. It is difficult to measure, since it is often concealed along the sides by the ovaries (Fig. 3, 1A, 1B, 1C). In view of the paucity of my observations I admit that a need may arise for some changes in the limits of the stages, but for the purposes of the present work these designations appear to be perfectly suitable.

The Normal Gonotrophic Cycle in Culicoides obsoletiformis Amosova

The results of dissections of fully engorged Culicoides fed on sugar syrup are presented in Table 1, in which the follicular development phases are used as the salient indicative characters because they are the most accurately determined.

Phase I of Christophers – Mer. Stage N_0 of Mer was observed only in the second follicle. The newly hatched female has the first follicle in phase I, stage N of Mer (Fig. 5, 4). It can also be seen in the second follicle of females with eggs ready for laying (Fig. 3, 1D) and in females just completing oviposition. The fat body of newly emerged female C. obsoletiformis occupies a small area (Fig. 5, 3).

Phase II. Stage IIA is reached by the follicles of females without a blood meal (Fig. 1, 1D and 5, 5 and 6). The follicle in this stage is oval in shape, the oocyte is either similar to the nurse cell or somewhat larger in size and contains minute yolk granules. Sometimes they were rather numerous and looked like minute iridescent granules in the live specimens. Stage IIA coincided either with phase 1 or phase 2 of the digestive process. During stage IIB the oocyte contained numerous yolk granules which gave the living cells a dark coloration. Stage IIB was only observed 12-15 hours after a blood meal by the female, which was then in digestive phase 3 of Sella.

Phase III of Christophers-Mer was observed in female C. obsoletiformis during digestive phase 4 of Sella. In time this phase coincides with the second (11 specimens) or the third (4 specimens) twenty-four hour period (30-58 hours after the blood meal).

Phase IV of Christophers-Mer, during which the oocyte occupies more than 0.75 of the length of the follicle, coincides with phase 5 + 6 of the digestion process (12 specimens) or more rarely with phase 7 (1 specimen) of Sella. At this time the second follicle is in stage N of Mer.

In C. obsoletiformis, phase IV includes the entire

TABLE 2

Condition of the Malpighian Tubules in Culicoides obsoletiformis Amosova during Various Phases of the Gonotrophic Cycle

Phase of the Malpighian tubules	Digestive phase of Sella						Number of females dissected
	1	2	3	4	5+6	7	
I	7	5	1	0	1	3	17
II	6	0	5	6	0	0	11
III	0	0	1	3	2	0	6
VI	0	0	0	2	9	1	12
V	0	0	0	0	2	10	12
					Total		58

process of form change in the follicle while growth is almost absent during this time. This conclusion was arrived at by calculating the mean volumes* of the eggs in the different phases of development (Table 1). The process of elongation of the follicle evidently proceeds rapidly, since in 35 females with follicles in this phase only 5 possessed follicles intermediate in shape between the initial and terminal conditions of phase IV (Fig. 2, $3D_1$ and $3D_2$). Phase IV is observed 50-78 hours after the blood meal (9 specimens reached phase IV during the third 24-hour period and 4 during the fourth).

Phase V (mature egg) is observed in the females which have digested the blood, that is, which have reached phase 7 of the digestive process of Sella. The abdomen is distended with mature eggs. This phase is observed from the fourth right up to the eleventh 24-hour period. Oviposition begins during the fourth 24-hour period or later, up to the eleventh. This prolongation of oviposition in the laboratory has been observed in Phlebotomus by Dolmatova (1942), who suggested that this could be related to the absence of a suitably humid substrate.

Two instances were noted in which immature eggs (in phases III and IV) were observed during digestive stage 7 of Sella; these could be explained by inadequate care of the flies during the experiment.

The mean number of eggs in a single gonad of C. obsoletiformis was 51 in stage IIA and 55 in stage IIB. In the initial stages a variation in number of eggs from 45 to 62 was noted in a single gonad. During development a gradual degeneration of some eggs takes place, such that the mean number of eggs in one gonad in phase V is 40 (29 to 58) (Table 1; Fig. 4), while the mean number of eggs laid by one female C. obsoletiformis in our experiments was 80. Thus, an average of about 28% of the follicles degenerated. The volume of a follicle increased at the expense of the food substance in the blood from $18 \cdot 10^{-6}$ mm^3 in stage IIA to $375 \cdot 10^{-6}$ mm^3 in the mature follicle stage, or about 20-fold.

The data collected on the activity of the Malpighian tubules was not extensive (from about 60 females), but the fact that these were discharged and then subsequently recharged in connection with the blood digestion process could be established even in this number of dissections (Table 2). These data are in basic agreement with those of other authors on mosquitoes (Beklemishev and Detinova, 1940; Almazova, 1940; Denisova, 1940), on Phlebotomus (Dolmatova, 1942; Shoshina, 1951), and on Culicoides (Glukhova, 1956, 1958); however, because of the paucity of my data I will not dwell on this problem.

The Role of Supplementary Carbohydrate Feeding

Several experiments, presented in Table 3, were carried out to show the influence of supplementary carbohydrate feeding on the development of the gonad in Culicoides. Fully engorged C. obsoletiformis females (a total of 39 specimens were dissected for this purpose), fed with sugar syrup (the first series), were kept under the same conditions as the second series, which was not fed sugar but which received only water. In spite of the small number dissected it was evident that the latter series was somewhat inhibited, as may be seen by the following (see also Table 3).

1) Instances of delay in follicle development were observed; thus, in 2 specimens out of 7 phase IIB of follicle development coincided with phase 4 of digestion; something which was not observed in a single one of the 8 females of the former series dissected during stage IIB; 2 cases out of 18 were observed where follicular phase IV coincided with digestive phase 7; in the series of females fed on sugar syrup this was not observed.

2) In the series of females not receiving syrup more degeneration of eggs was observed during the process of development (Table 3 and Fig. 4, from which it may be seen that about 44% of the follicles degenerated as opposed to 28% in the first series).

*Follicular volume was estimated according to the formula of an ellipsoid of rotation $v = (4/3)\pi a^2 b$, where a is the radius of cross section and b is half the length of the follicle.

TABLE 3

Gonotrophic Cycle of Fully Engorged Culicoides obsoletiformis Amosova not Receiving Sugar Syrup but Only Water (from dissections)

Phase of follicle development	Time elapsed since blood meal (in hours)	Digestive phase of Sella	Stomach dimensions (in mm)		Gonad dimensions (in mm)		Follicle dimensions (in mm)		Number of eggs per gonad	Mean volume of follicles	Number dissected
			length	width	length	width	length	width			
IIA	—	—	—	—	—	—	—	—	—	—	—
IIB	12—31	3 (5 ♀+♀) 4 (2 ♀)	0.65	0.5	0.28—0.4	0.1—0.15	0.045—0.07	0.03—0.04	41—61 (50)	—	7
III	28—50	—	0.55—0.7	0.35—0.5	0.3—0.55	0.15—0.25	0.065—0.115	0.045—0.06	39—65 (50)	—	12
IV	50—80	5—6 (16 ♀) 7 (2 ♀)	0.45—0.6	0.1—0.35	0.38—0.06	0.1—0.35	1) 0.10—0.16 2) 0.18—0.28 0.32	1) 0.062—0.09 2) 0.065—0.068 0.055	19—51 (37)	—	18
V	72 — 6th day	7 ♀	Stomach empty		0.5	0.25			23—47 (31)	—	3
									Total		40

In spite of the small number of experiments, it may be said that the lack of supplementary carbohydrates lowers the fecundity of the female somewhat, but that the supplementary intake of carbohydrates (from plane sap in nature) is not obligatory for gonad development. Hence, in the composition of the blood ingested the flies obtain all substances necessary for gonad development. By analogy with mosquitoes (Beklemishev, 1944, 1957; Detinova, 1953) and flies (Derbeneva-Ukhova, 1935) a pure carbohydrate diet in Culicoides serves only to sustain the life of the female itself.

The Gonotrophic Cycle in Culicoides obsoletiformis Amosova after an Incomplete Blood Meal

Dissections were carried out on 46 female C. obsoletiformis which had received an incomplete blood meal and supplementary sugar syrup in order to clarify the question as to whether it is possible for eggs fully to develop in incompletely engorged females.

By weighing 100 fully engorged and 100 starved females of C. obsoletiformis the mean quantity of blood ingested by one female of this species was determined. It is 0.112 mg for a 0.075 mg mean weight of the starved female. Thus, the weight of the blood ingested is almost one and a half times that of the body (1.48). The weighing of incompletely engorged flies was carried out with an isolated series of females which had received a minimal quantity of blood (sometimes not resulting in the development of the gonads). This quantity of blood was so small that the body weight of 100 incompletely fed females was equal to that of 100 starved females.

Most of the third series (females without a full blood meal but fed on sugar syrup) had the follicles developing at a normal rate (Table 4). We will focus our attention on certain facts regarding the retardation of development observed in a group of females which had received a particularly small portion of blood. In 3 females at the second 24-hour period after the blood meal the follicles remained undeveloped (stage IIA), even though by color the blood could be related to phase 4 of the digestive process. Detailed comparisons by individual phases were not carried out. However, the following conclusions appear convincing. With incomplete engorgement only a portion of the egg tubes in the gonads develops (Table 4 and Fig. 4). The smallest number of eggs developing in one gonad was 10, the largest 27 (mean, 19). That is to say that an average of 66% of the follicles degenerated. The reduction in the number of developing follicles occurs suddenly, as may be seen by comparing the number of eggs in individual series (Table 4 and Fig. 4). However, degeneration also

TABLE 4

Gonotrophic Cycle of Culicoides obsoletiformis Amosova Which Have Received an Incomplete Blood Meal and Sugar Syrup (from dissections)

Phase of follicle development	Time elapsed since blood meal (in hours)	Digestive phase of Sella	Stomach dimensions (in mm)		Gonad dimensions (in mm)		Follicle dimensions (in mm)		Number of eggs per gonad	Mean volume of follicles	Number dissected
			length	width	length	width	length	width			
IIA . .	A few hours (4 ♀)	2	0.42—0.5	0.1—0.23	0.2	0.05—0.08	0.03—0.04	0.02—0.025	—	—	7
	24—36 (3 ♀)	4									
IIB . .	21—36	5	0.35—0.56	0.2—0.32	0.25—0.33	0.12	0.05—0.07	0.03—0.045	26—55 (45)	—	8
		7 (1 ♀)									
III . . .	24—38	—	0.4	0.22	0.38—0.4	0.15—0.22	0.065—0.135	0.045—0.08	12—28 (21)	—	11
IV . . .	48—71 (3 ♀), 9th day (1 ♀)	—	—	—	0.38—0.52	0.2	1) 0.13—0.145 2) 0.29	1) 0.07—0.08 2) 0.052	12—22 (17)	—	4
V . . .	72 — 11-th day	7	Stomach empty		0.52—0.55	0.25	0.295—0.305	0.045—0.05	10—27 (19)	366 × 10^{-6} mm³	16

TABLE 5

Gonotrophic Cycle in Normally Engorged Culicoides pulicaris L. Fed on Sugar Syrup (from dissections)

Phase of follicle development	Time elapsed since blood meal (in hours)	Digestive phase of Sella	Stomach dimensions (in mm)		Gonad dimensions (in mm)		Follicle dimensions (in mm)		Number of eggs per gonad	Mean volume of follicles	Number dissected
			length	width	length	width	length	width			
II A . .	—	1	—	—	0.25	0.1	0.050—0.055 (0.052)	0.03—0.04 (0.035)	— (67)	31 · 10^{-6} mm³	2
II B . .	6—8.5	3	0.8—1.5 (1.1)	0.5 (0.5)	0.23—0.55 (0.39)	0.12—0.20 (0.15)	0.048—0.065 (0.056)	0.034—0.042 (0.039)	50—72 (64)	42 · 10^{-6} mm³	7
III . . .	(30—36, (33)	4	0.85—1.0 (1.16)	0.3—0.55 (0.41)	0.3—0.55 (0.44)	0.17—0.30 (0.21)	0.072—0.120 (0.081)	0.04—0.075 (0.057)	45—71 (57)	129 · 10^{-6} mm³	9
IV . . .	35—80 (52)	5—6	0.7—0.9	0.12—0.3	0.4—0.7	0.25—0.37	1) 0.110—0.160 (0.136) 2) 175—0.225 (0.200)	1) 0.07—0.095 (0.083) 2) 0.060—0.085 (0.070)	36—63	482 · 10^{-6} mm³	12
V . . .	72 — 6th day	7	Stomach empty		1.0	0.35	350—385 (0.365)	0.06—0.063 (0.061)	34—66 (55)	665 · 10^{-6} mm³	13
										Total	43

proceeds during the entire course of the egg development period, as is shown by the presence of follicles in various stages of degeneration in a single ovary (Fig. 2, 2D) containing anything from large follicles with yolk remains in the center down to minute, wrinkled sac-like remnants. Oviposition was also observed in this series of experiments, beginning in the fourth 24-hour period and continuing right up to the 10th or 11th 24-hour period in some females. Larvae were reared from several egg masses, demonstrating the viability of the eggs obtained from incompletely engorged females. The dimensions of the mature eggs of these females varied within normal limits.

Glukhova (1958) observed a partial maturation of eggs after incomplete engorgement in C. obsoletus (Mg.) and C. grisescens Edw.; in C. obsoletus (Mg.) oviposition and larval hatching were observed.

Thus, as in Phlebotomus papatasii Sc. and several species of Aëdes (Detinova, 1942, 1943), "a higher degree of gonotrophic harmony, whereby the number of developing eggs depends on the quantity of blood ingested" (Detinova, 1953) is characteristic of Culicoides.

The Normal Gonotrophic Cycle in Culicoides pulicaris L.

Dissection of C. pulicaris females collected after normal blood feeding confirmed the presence of a normal gonotrophic cycle in these also.

Degeneration of some portion of the follicles was also noted in this species when kept in the laboratory. The initial number of follicles in one ovary at stage IIA averaged 67. At phase V an average of 49 were counted in an ovary. Thus, degeneration averaged 18%. By weighing 100 normally fed and 100 starved female C. pulicaris it was shown that the weight of blood ingested by one female was 0.145 mg, or somewhat less than the body weight of the female, which was 0.180 mg. The volume of the follicles increased from phase IIA to phase V about 20-fold, as in C. obsoletiformis (from $31 \cdot 10^{-6}$ mm^3 to $665 \cdot 10^{-6}$ mm^3). Mature eggs were also observed at the fourth 24-hour period (Table 5). As opposed to C. obsoletiformis, not only form change, but also growth of the follicle, takes place during phase IV in C. pulicaris.

The Possibility of Autogenic Egg Development in Culicoides dendrophilus Amosova

Many bloodsucking species are known in the genus Culicoides. Data are lacking on the feeding habits of a comparatively large proportion of the species; however, judging by the developed proboscis, it has been assumed that all species of Culicoides are bloodsuckers. Of the 20 species in my collections of 1953-1954 nine were collected from hosts. This may be partly explained by the rarity of some species, but it could be connected with different feeding habits in the female.

Thus, it has been established that C. dendrophilus Amosova that the first batch of eggs develops without the prior ingestion of blood. Sections through the newly emerged female of this species (one specimen) revealed distinct differences from the two bloodsucking species (C. obsoletiformis and C. pulicaris). The first follicles of the newly emerged female C. dendrophilus contained oocytes filled with numberous yolk granules. In size the oocyte attained and even slightly exceeded 0.5 that of the follicle, a fact which should be associated with stage IIA or even phase III in development (Fig. 5, 2). The length of this follicle was 0.07 mm. The mature egg attained 0.40 mm in length, whereas in the newly emerged C. obsoletiformis female the follicle was in stage N (phase I) and measured 0.016 mm in length (Fig. 5, 4); in C. pulicaris at the same stage the length was 0.020 mm. The fat body of C. dendrophilus was strongly developed and filled the whole space between organs (Fig. 5, 1). This is particularly prominent in comparison with the fat body of C. obsoletiformis (1 specimen; Fig. 5, 3) and C. pulicaris (4 specimens). In the latter two it occupies a comparatively small space.

In the mosquitoes and black flies (Monchadskii, 1937; Rubtsov, 1956) the phytophagous way of life in both the larvae and adults is the primitive one and is preserved in many members of these families. In the mosquitoes (except in the wholly phytophagous subfamily Dixinae) "this more primitive type becomes modified to the extent that either the adult females become bloodsuckers or the females continue to feed on plant sap while the larvae become predatory" (Monchadskii, 1937). In all mosquitoes except the Dixinae "feeding on animal protein during one of the phases of development has become an obligatory precondition for the maturation of the genital products" (Monchadskii, 1937). By analogy with the mosquitoes, protein feeding in the larvae of C. dendrophilus should also be looked for. The larvae and pupae of this species are found in flooded tree hollows in large numbers. The larvae either dig down deep into the crumbled wood or swim in the water layers above the wood. Specific observations on

larval feeding have not been carried out since the very fact that the eggs are laid without the prior ingestion of blood was discovered only upon arrival at Leningrad. However, while still in the Far East I once succeeded in observing a concentration of C. dendrophilus larvae on the dead body of a beetle larva which had lived in the same hollow, a fact which demonstrates the possibility of necrophagy. It is presently impossible to resolve the question of whether it is possible for the second follicles to develop without a blood meal.

The fact that the first batch of eggs may develop without a blood meal is also known for the bloodsucking mosquitoes: Culex pipiens L., Stegomyia scutellaris (Hect, 1933), Aëdes concolor, Theobaldia subochrea Edw. (cited in Markovich, 1941), and Anopheles bifurcatus L. (Markovich, 1941). Beklemishev (1942) considers this a first step toward the secondary loss of the bloodsucking habit. In the case of C. dendrophilus it also seems more natural that this is a secondary loss of the bloodsucking habit in view of the fact that the mouthparts of this species belong to the piercing-sucking type; their foreshortening strongly suggests a lack of the capacity to suck blood.

Data are now available on the existence of the gonotrophic cycle in 4 species of Culicoides: C. obsoletus (Molev, 1955; Glukhova, 1956, 1958), C. pulicaris (Molev, 1955; Amosova, 1956, 1958), C. obsoletiformis (Amosova, 1956), and C. nigrescens (Glukhova, 1956).

In addition, the capacity for the autogenic development of the first batch of eggs has been established for several species (C. dendrophilus, – Amosova, 1956; C. circumscriptus Kieff. – Glukhova, 1956, 1958; and C. riethi Kieff. – Krivosheina, 1956, 1957).

By all accounts it seems that the genus Culicoides contains species which differ in their life histories and that besides obligate bloodsucking there are species which are moving toward the loss of the bloodsucking habit.

SUMMARY

The data for this investigation were collected during the summer of 1954 in the Suputinka Reservation (Maritime Territory). Gonotrophic relations in Culicoides obsoletiformis Amosova and C. pulicaris L. are described. The phases of digestion and follicle development adopted for other bloodsucking Diptera were applied to these species with slight modifications (Figs. 1, 2 and 3).

Three series of experiments were made with C. obsoletiformis. The subject of the first and second series were fully engorged females. In the first series the females received sugar syrup as supplementary feeding while in the second series they were supplied with water only. In the third series the females that were not fully engorged but had received only a part of the quantity of blood required, were supplied with sugar syrup for supplementary feeding. In all the three series the complete maturation of eggs and the beginning of oviposition was recorded on the fourth day. The average fecundity of females supplied with water only (Table 3) was lower than that of females supplied with sugar syrup (Table 1), the proportions of degenerating eggs being 44 and 28% respectively. It was thus established that a supplementary carbohydrate feeding is not absolute indispensable, although without it the fecundity of females is considerably reduced. In the females that had received only a part of the amount of blood required only 19 follicles per gonad out of 55 (in the average) attained phase I of maturation, the average proportion of degenerating eggs being 66%. This indicates that in C. obsoletiformis the fecundity of females depends on the amount of blood consumed.

It has been established that in C. dendrophilus Amosova the first batch of eggs is deposited without any preliminary bloodsucking. At the time of emergence the female of this species has large follicles at phase III of maturation and a well-developed fat body (Fig. 5, 1, 2). In C. obsoletiformes and C. pulicaris the fat body is poorly developed, and the follicles attain, at the time of emergence, but an early phase of maturation (phase N).

According to the data obtained from mosquitoes by A. S. Monchadskii 1957, it can be expected that the food of C. dendrophilus includes animal proteins.

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THE SPECIES OF SARCOPHAGID FLIES (DIPTERA) IN THE SYNANTHROPIC FAUNAL COMPLEXES OF VARIOUS LANDSCAPE ZONES IN THE USSR

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The members of the dipterous subfamily Sarcophaginae – the familiar grey flesh flies – are some of the commonest elements of any synanthropic fly complex in the temperate and tropical zones of the earth. In spite of their wide distribution and great systematic diversity the study of sarcophagids has proceeded slowly so far; the reason for this is probably the comparative paucity of true sinanthropes among these flies. For instance, even the most preliminary investigative step, namely the clarification of the faunal composition, has not even been remotely realized in the sarcophagids; until recently more or less definite data were available for only a few of the most studied areas. The aim of the present communication is to examine the results of investigations on the synanthrope fauna of the USSR in order to characterize concisely the sarcophagid composition of certain faunal complexes in various regions of our country.

The very concept of a "synanthropic" or "symbovine" form with regard to sarcophagid species has not yet been adequately formulated. Without concerning ourselves with the essence of this problem, which is related to certain features of the life history of the insect, in particular with factors of larval food and development on the one hand, and the ecology of the winged insect on the other, we must depend upon available factual data (Gregor and Povolny, 1958) in order to clarify the composition of faunal complexes. These data are large-scale collections of flies from various environments in populated localities, collections of flies from respective bait substrates, and finally, results of experimental work on obtaining larvae and rearing winged insects. Most of the data were obtained as a result of collections from fly-traps in populated localities and from baits situated far from dwellings; accurate verifications of the ecology of a species by means of laboratory rearings were carried out in only a few cases.

Sarcophagids may be roughly placed in the following groupings on the basis of larval ecology and feeding habits:

1) Coprophages. These live in animal excrement, dung, or human feces. Examples are Belliera melanura (Meig.), Coprosarcophaga haemorrhoidalis (Fall.), and Ravinia striata (Fabr.).

2) Schizophages. These live in animal carcasses (vertebrates, insects, and others), in meat, and rarely in other decaying organic matter. An example is Parasarcophaga tuberosa (Pand.).

3) Predators. Preying upon quiescent stages in the development of other insects (pupae and prepupae of Lepidoptera, egg masses of grasshoppers). Examples are Parasarcophaga pseudoscoparia (Kram.), Parasarcophaga uliginosa (Kram), and Kramerea schutzei (Kram.).

4) Parasites. Living in the body cavity of insects, in the body of other animals or the wounds of vertebrates; the attacks of these larvae do not bring about the rapid death of the animal host. Examples are the species of the genus Blaesoxipha and related ones.

A widespread polyphagy among sarcophagids indicates that this general scheme must be broadly supplemented. Because of this polyphagy several coprophages may live in decomposing meat or carcasses and

necrophagous forms could be found in excrement or dung. Similarly many predators may begin their development in live insects and conclude it in dead bodies already in decomposition. The parasites are more selective in their food, but different types of food habits are observed even here; this is particularly true with regard to larvae which inhabit the wounds of vertebrates, among which we may distinguish obligatory causative agents of myiasis, and facultative wound parasites which may also develop in carcasses and which are essentially schizophages. Several forms of sarcophagids are known which display a particularly wide range of polyphagy, such as the African and Near Eastern desert species Phytosarcophaga destructrix (Mall.), the larvae of which may live in dead grasshoppers, decaying meat, and rotten cantaloupes and watermelons (Rodendorf, 1937, Sukhova, 1957).

Determining the ecological characteristics of a species presents a complicated problem when a still poorly studied region is investigated faunistically for the first time. In this case the behavior of the winged insect is used, in particular its attraction to a given bait, together with data on its abundance in the fauna. Obtaining larvae and rearing them is the simplest method of determining the developmental characteristics of a given species.

Thus, in the subsequent survey of the species of Sarcophaginae their life habits are indicated by a corresponding symbol placed after the specific name. These symbols are the numbers of the four ecological groups described above, that is, 1, 2, 3, 4 or 1-2, 2-3, etc. (compound numbers indicating polyphagy). In the cases where the data on larval habits are assumed on the basis of observations on the winged insects and their attraction to given baits, the numbers are placed in parentheses.

Some species with very distinct geographical distributions enter into the composition of different sarcophagid synanthropic faunal complexes. Three species are basically distributed throughout all the faunas (list 1):

Coprosarcophaga haemorrhoidalis (Fall.) 1
Bellieria melanura (Meig.) 1—2
Ravinia striata (Fabr.) 1—2

The first two species are widely distributed outside the Palearctic; the last is a widely distributed Palaearctic one.

The following species are also very widely distributed and are absent in only a few faunas. These are six in number (list 2):

Sarcophaga carnaria (L.) 3 (1—2)
Parasarcophaga argyrostoma (R.-D.) 1—2
Parasarcophaga crassipalpis (Macq.) 2—1
Parasarcophaga albiceps (Meig.) 1—2
Parasarcophaga similis (Pand.) 2
Parasarcophaga tuberosa (Pand.) 2

The first species is distributed throughout the Palearctic; the remaining five are also represented in the Oriental and Nearctic regions.

A large group of fairly widely distributed species is purely Palearctic with the exception of the last three, which are Holarctic (list 3):

Parasarcophaga parkeri Rohd. 2—1
Parasarcophaga jacobsoni Rohd. 1—2
Parasarcophaga emdeni Rohd. (1)
Parasarcophaga pseudoscoparia (Kram.) 3
Parasarcophaga uliginosa (Kram.) 3
Kramerea schützei (Kram.) 3
Parasarcophaga harpax (Pand.) (2)
Parasarcophaga scoparia (Pand.) 3
Sarcotachinella sinuata (Meig.) (1)

Finally, in addition to the species of the three groups indicated, each faunal complex contains a greater or lesser number of local species which are partly endemic and partly representative of foreign, non-Palearctic faunal elements.

A survey of the synanthropic sarcophagid fauna of the USSR shows that it is possible to distinguish several faunal complexes which reflect the known zoogeographical features of the corresponding region of the country.

I have adopted a total of six complexes which are not equal in degree of relationship; it is possible that with further study and clarification they will become partly united or, conversely, further subdivided:

1) The taiga-forest complex.

2) The steppe complex.

3) The Mediterranean (Crimeo-Caucasian) complex.

4) The desert complex.

5) The montane Central Asian complex.

6) The Far Eastern complex.

1) The taiga-forest faunal complex. This complex is distributed over a large part of the European territory of the USSR (north of the steppe zone) and nearly all of Siberia (except for the Amur and the Maritime Territory). Throughout this broad expanse of territory the species of synanthropes are probably not uniform; it is possible even now to distinguish differences between the Siberian and European fauna, a fact which provides the basis for proposing a subdivision of this complex into a European and Siberian fauna.

The over-all specific composition of this complex is comparatively small (containing 17 species). It includes, besides the three widely distributed species of the first list, four species of the second list: Sarcophaga carnaria (L.), Parasarcophaga albiceps (Meig.), P. similis (Pand.), and P. tuberosa (Pand.). Here, however, nearly all the species of the third list are present, including all five of the predators: Parasarcophaga pseudoscoparia (Kram.), P. scoparia (Pand.), P. uliginosa (Kram.), P. aratrix (Pand.), and Kramerea schutzei (Kram.), plus Sarcotachinella sinuata (Meig.) and Parasarcophaga emdeni Rod. (the latter only in Siberia!). In addition, this complex includes some widely distributed, primarily northern species: Sarcophaga subvicina Rod. (1-2), Belliera crassimargo (Pand.) (2), Thyrsocnema kentejana Rod. (2), Th. sororcula Rod. (1) (the latter only in Siberia!). A fundamental feature of the taiga-forest fauna is the presence of many species of the genus Parasarcophaga and the absence of three widely distributed southern brightly colored ("red-tailed") species: Parasarcophaga parkeri Rod., P. argyrostoma (R.-D.), and P. crassipalpis (Macq.).

As has already been pointed out, the eastern portion of the distribution of this complex, namely Siberia, is distinguished by a somewhat different faunal character; aside from the presence in Siberia of several species which are absent from the European part of the USSR (in the present complex) and which are mentioned above, the widely distributed species Coprosarcophaga haemorrhoidalis (Fall.) is distinctly rarer in Siberia, and in some places has not yet been discovered.

Literature. Rodendorf, 1937, Shtakel'berg, 1956; Sukhova, 1957; Beklemishev, 1958.

2) The steppe faunal complex. The general distribution of this fauna corresponds with the steppe zone in the south of the European part of the USSR, most of Kazakhstan, and southern Siberia in the east. The over-all number of species is 23; it includes all forms in the three lists and five more: Parasarcophaga portschinskyi Rod. 1, Belliera macrura Rod. 1, B. crassimargo (Pand.) (1), Sarcophaga subvicina Rod. (1-2), and Parasarcophaga aratrix (Pand.) (3). On the whole this complex approaches the Crimeo-Caucasian one and includes some common, probably Mediterranean features. The species of the genus Sarcophaga continue to play an important role in this complex; particularly characteristic is the presence of the indicated species of Belliera and Parasarcophaga.

Literature. Rodendorf, 1937; Petrova, 1942; Sukhova, 1952, 1957; Sychevskaya, 1957a; Beklemishev, 1958.

3) The Mediterranean (Crimeo-Caucasian) faunal complex. Within the limits of our country this faunal complex occupies the extreme south of the Ukraine (including Crimea), the North Caucasus, and the Transcaucasus. The over-all number of species 21; on the whole the specific composition is similar to that of the steppe complex. All the species of the three lists are present except for two predators [Kramerea schutzei (Kram.) and Parasarcophaga pseudoscoparia (Kram.)] and the minor, relatively rare species Sarcotachinella sinuata (Meig.). The steppe species Belliera macrura Rod. and also B. crassimargo (Pand.) are likewise absent. The appearance here of the truly Mediterranean Parasarcophaga exuberans (Pand.) and the endemic Caucasian (Abkhasian) species Sarcophaga apsuarum Rod. is significant. In addition, the desert species Belliera maculata (Meig.) 1 is

encountered in sandy locations. It must be pointed out that the synathropic flies of the Caucasus have been insufficiently investigated, and that they probably form local faunal complexes in such areas as the Black Sea littoral, the montane country of the Greater and Lesser Caucasus, and the Talysh.

Literature. Rodendorf, 1932, 1937; Kalandadze and Chilingarova, 1940; Trofimov and Éngel'gart, 1948; Trofimov, 1948, 1957; Drenski, 1957; Beklemishev, 1958.

4) The desert faunal complex. The extent of the desert fauna of the USSR encompasses the deserts of Central Asia and several areas of the Caucasus. The synanthropic desert fauna is one of the poorest in number of species. The over-all number of species does not exceed 11. The three widespread species of the first list are present here, also three species of the second list [Sarcophaga carnaria (L.), Parasarcophaga argyrostoma (R.-D.), and P. crassipalpis (Macq.)], two species of the third list (Parasarcophaga parkeri Rod. and P. jacobsoni Rod.) and, finally, three unique, characteristic desert species: Belliera maculata (Meig.) 1, Parasarcophaga hirtipes (Wied.) 1, and P. semenovi Rod. 2. The two latter species are presently known only from deserts, while the latter is a Central Asian endemic in addition. An important feature of this complex is the absence of any predatory species from the third list, these being closely associated with forest vegetation and shade. The relations of the desert complex with others, especially the Mediterranean and montane Central Asian, are very close, with several instances of intrazonal penetration of individual species [for instance, Belliera maculata (Meig.) into the Mediterranean complex with sandy conditions and also into the montane Central Asian]. The entire desert complex as whole is widely distributed outside the USSR and encompasses a wide expanse of territory in Central Asia and the Near East, North Africa, and probably part of south Asia (the deserts of Pakistan), being represented within our borders only by its northern fringe. Because of this our knowledge of its specific composition is probably still very incomplete.

Literature. Romanov, 1940; Zimin, 1944a-1944b; Petrova, 1948; Sukhova, 1952, 1957; Sychevskaya, 1956, 1957b, 1958; Beklemishev, 1958.

5) The montane Central Asian complex. The range of this complex is very local and essentially includes only the Tian Shan and Pamir-Alai mountain systems; the distribution of this fauna in China remains unclear. The specific composition is rather rich and includes no less than 26 species. Species from all three lists are present except Parasarcophaga albiceps (Meig.) and P. similis (Pand.) from the second list, and three predatory species [Parasarcophaga pseudoscoparia (Kram.), P. scoparia (Pand.), and Kramerea schutzei (Kram.)] from the third list. In addition, some species common to the steppe complex are represented: Belliera macrura Rod. 1, Parasarcophaga portschinski Rod. 1, and Belliera crassimargo (Pand.) (1). Here also are species which bring this fauna closer to the Siberian section of the taiga-forest complex [Thyrsocnema sororcula Rod. (1)] the desert complex [Belliera maculata (Mg.) 1] and the Mediterranean complex [Parasarcophaga exuberans (Pand.) 1]. A fundamentally characteristic feature of the complex is the presence of several unique species evidently endemic to the mountains of Central Asia, namely Parasarcophaga feldtschenkoi Rod. (1-2), P. pleskei Rod. (1), and P. kirgizica Rod. (2). To the latter species we must also add several of the genus Pierretia which show synanthropic features, in particular P. plotnikovi Rod. 1, P. shnitnikov Rod. (1), and P. filia turana Rod. (1); the first two species are endemic to the Tian Shan mountain country while the latter is a subspecies of a Mediterranean species which has not hitherto been studied biologically. On the whole, with regard to the montane Central Asian complex it must also be pointed out that its composition still has not been sufficiently studied.

Literature. Rodendorf, 1937; Vainshtein and Rodova, 1940; Zimin, 1944a; Sychevskaya, 1957b, 1958.

6) The Far Eastern faunal complex. The limits of distribution of this complex in the USSR cannot yet be accurately traced; in general terms it includes the southern Maritime Territory and part of the Amur. The species making up this complex are fairly numerous and number 24. Most characteristic is the presence of numerous extra-Palearctic species belonging to the Oriental region. Nearly all of the species of all three lists are present; only Parasarcophaga parkeri Rod., P. emdeni Rod., P. argyrostoma (R.-D.), and P. jacobsoni Rod. are absent; the latter is known from neighboring countries (Korea) and probably is found with us. One of the European-Siberia taiga-forest species is also found in the Far Eastern fauna [Thyrsocnema kentejana Rod. (2)] But most characteristic is the presence of numerous Oriental species which are true, widely distributed synanthropes. These are primarily the species of the genus Boettcherisca [B. peregrina (R.-D.) 2 and B. septentrionalis Rod.2] Parasarcophaga [P. knabi (Park.), 1-2, P. unguitigris Rod. 1-2, P. macroauriculata (Ho) (1), P. tsushimae (S.-W.) 2 and P. polystylata (Ho) 2], and the unique Oriental genera Chrysosarcophaga [Ch. antilope (Bott.) (2)]

and Phallocheira [Ph. minor Rod. (1)]. Finally, the Maritime species Thyrsocnema ugamskyi Rod. 2 has a definite synanthropic importance in neighboring countries (Japan). This composition of the synanthropic fauna of the Far East, particularly of the southern Maritime, clearly demonstrates the separateness of this region, which is an extreme northern segment of the Oriental region. The species mentioned above, especially Boettcherisca peregrina (R.-D.), Barasarcophaga knabi (Park.), Chrysosarcophaga antilope (Bott.), and probably other species, are widely distributed in the Oriental region right down to its extreme southern edge, being characteristic synanthropic forms everywhere. It should further be pointed out that the specific composition of the Far Eastern complex has also probably been incompletely studied; many synanthropic species widely distributed in neighboring countries, in China and Japan, whose presence in the USSR is altogether possible, have not yet been found here. This might include such species, widespread in China and Japan, as Parasarcophaga brevicornis (Ho) (2), P. misera (Walk.) 2, P. ochidea (Bott.) 2 and species from southern China and Japan like Thyrsocnema josephi (Bott.) (2), Sinonipponia erecta (Ho) (2), and Seniorwhitea orientaloides (S.-W.) 2.

The interrelationships of the taiga-forest and desert faunas to the Far Eastern one remain unclear; the solution of this problem awaits understanding of the synanthropic fauna of China and Korea.

Literature. Ho, 1932, 1936; Rodendorf, 1937, 1938; Rodendorf and Grunin, 1938; Hori, 1950, 1951a, 1951b, 1952, 1953; Kano, 1950, 1951, 1952, 1953, 1954a, 1954b; Quo, 1952; Sukhova, 1952, 1957; Shtakel'berg, 1956; Beklemishev, 1958.

The preceding brief faunal survey of the synanthropic sarcophagids is an initial and largely preliminary outline. It probably includes many lacunae and inaccuracies which are partly the result of uncertainty about the concept of sarcophagids as synanthropes and especially the result of incompleteness in our information concerning the synanthropic complexes of the Eastern regions.

SUMMARY

The Sarcophaginae are distributed among 4 ecological groups: 1) coprophagous, 2) schizophagous, 3) predators, 4) parasites. The representatives of the first three groups appear to be members of synanthropic complexes, while parasites are only accidentally found near human dwellings. Coprophagous and schizophagous forms (feeding usually upon corpses and other decayed matter) are the most significant, many species being polyphagous to a certain extent. The determination of the synanthropic nature of different species is carried out by means of collecting the insects and hatching their larvae; hatching of flies from larvae on substrata is the principal evidence for ecological characteristics. In the lists the ecological characteristics are given by indices – figures showing the ecological group; data checked by hatching the larvae on a substratum are given in simple figures, others are given in parentheses.

The main composition of synanthropic fauna consists of the 18 species enumerated in lists 1, 2, 3. These are widely distributed palearctic, sometimes holarctic, or the most widespread forms. Different landscape zones of the USSR – taiga-forest, steppe, Mediterranean (Crimeo – Caucasian), desert, montane Central Asian, Far Eastern – are inhabited by the majority of widely distributed species plus some local species. Thus 4 local species join the taiga-forest complex, 3 species – the mediterranean complex, 2 species – the desert complex, 6 species – the montane Central Asian complex, and 10 species – the Far Eastern complex.

The unique Far Eastern complex is the most separated one since it belongs to another zoogeographical region. The taiga-forest fauna consists of 18 species, the steppe fauna – of 23 species, the Mediterranean fauna – of 21 species, the desert fauna – of only 11 species, the montane Central Asian fauna – of 26 species and the Far Eastern fauna – of 25 species. The total list of synanthropic species for the USSR consists of 46 species; some widely distributed Oriented or Chinese species have not yet been discovered in the territory of the USSR and hence are not included in the list. Our knowledge of the eastern districts of the USSR with regard to their faunistic composition of synanthropic Sarcophaginae is not sufficient. This review is the first attempt to bring together all the data.

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FEEDING OF THRIPS ON THE POLLEN OF FLOWERS AND THE ORIGIN OF ASYMMETRY IN THEIR MOUTHPARTS

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Thrips are well known inhabitants of flowers. How flowers attract thrips and what role they play in the life of the latter has remained unknown until now. The flower is the organ adapted to the cross fertilization of plants by means of insects and the question naturally arises as to whether the thrips may be important as pollinators. Furthermore, thrips may cause damage to the flowers by feeding on sap. It is important to know what thrips feed on in flowers.

The constituent elements of flowers are pollen and nectar. Thrips are unable to ingest pollen since they possess piercing mouthparts; they are able to take in only liquid food. Nectar could not be their principal food; the structure of their mouthparts indicates this. Piercing mouthparts are not necessary for imbibing nectar lying exposed at the base of the flower. Thrips may drink nectar and, according to our observations, sometimes do drink it by means of the oral cone. This is the reason for the widely accepted idea that thrips feed on the juices of the flower itself.

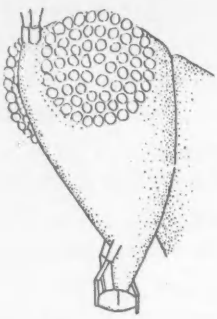
The study of the food habits of flower-associated insects of various orders has enabled us to establish the fact that pollen is very important as insect food.* Pollen contains much protein, fat, and carbohydrate and exceeds all other parts of the plant in food value. Being in constant contact with pollen, thrips must show some trophic relationship to it. However, pollen is eaten only by insects with chewing mouthparts. Among sucking insects pollen feeding is unknown, unless we consider the single known instance recorded in the literature (Downes, 1955) concerning a bloodsucking sand-fly Atrichopogon pollinivorus of the family Heleidae. Until now it has been assumed that the minute size of individual pollen grains did not allow the extraction of their liquid contents. The possibility of feeding on pollen was recognized only for chewing insects capable of swallowing the grains.

I was first to establish the fact that thrips feed on pollen during an investigation of pine anthers. Immature anthers of pine contained a mass of Oxythrips brevistylis brevistylis Trybom larvae which reached adulthood at the maturation of the anthers. The minute size of the larvae did not allow me to carry out accurate observations on their feeding habits since I did not have the requisite optical instruments at the time. But since the sole source of food in anthers is pollen there could be no doubt that the thrips larvae sucked out the contents of the pollen.

METHODS

Observations on the feeding habits of thrips were carried out on freshly picked flowers under laboratory conditions with a binocular microscope MBS-1 under high magnifications. Magnifications of 68 was used; 34 power could be used with flowers possessinglarge pollen grains (Convolvulus). A binocular of this type may give a maximum magnification of 119, but the great mobility of the thrips, and the reduction in the sharpness of the image precluded the use of this magnification. For observation purposes open flowers were used in which the

*The present paper represents part of a series of works devoted to the study of various groups of insects associated with flowers (Grinfel'd, 1955, 1957).



A thrips sucking on a pollen grain. The stylet (mandible) is visible through the pollen grain wall.

anthers were visible (Convolvulus, Ranunculus, Tanacetum, milfoil, Anthemis, Sonchus, dandelion, Elecampane, Centaurea). In cleistogamous flowers of the papilionaceous type it was not possible to observe the thrips since the stamens and pistils were hidden in the keel. For observation of feeding habits in cleistogamous flowers the thrips were transferred (shaken out) into open flowers and thus observed. Many of the thrips scattered or took flight under these conditions, but some of them remained in the new flower and continued to feed.

The work was carried out in the summer of 1957 in the forestry training farm "Les na Vorskle" in the Belgorod Region.

The thrips seeks out a pollen grain in the flower. By means of the anterior legs it grasps a grain which is either in front of or to the side of the head and brings it down toward the oral cone. In some species there are small teeth on the inside of the anterior tibiae which facilitate the grasping of the pollen grain. During feeding the pollen grain is held behind by the pair of labial palps and in front by the pair of maxillary palps (see figure) and oriented in front of the end of the oral cone. In this position the thrips is able to move from one place to another while carrying the pollen grain. The grain may be sucked out without the aid of the palpi. At the moment of feeding the pollen grain is pressed against the substrate and the stylet is thrust into it. Judging by its shape it is the mandible. The minute size of the mouthparts and the capsule around the pollen grain impede accurate observation, but when the subject is illuminated by the sun and the insect is suitably oriented under the binocular, it is possible to observe, at 68 magnifications, how one stylet penetrates the pollen grain — it is visible through the wall of the grain. It is particularly clearly seen when Aeolothrips fasciatus L. is feeding on Convolvulus pollen, which has a smooth outer wall.

After the piercing of the outer wall the mandible is retracted into the end of the oral cone and the process of imbibing the plasmatic contents of the pollen grain proceeds. The following different events in this process may be observed: one, the end of the oral cone presses down into the grain, pushing it against the substrate, while the liquid contents issuing through the break are imbibed with the result that the cell wall collapses and becomes flat; or two, the pollen grain retains its original form, but it is seen to be losing its liquid contents and becoming filled with air; it may be seen when the subject is illuminated with sunlight how the fluid is moving inside the grain while the cell wall loses its shiny texture and becomes dull. The liquid contents of the pollen grain are sucked up by means of the oral cone, the end of which is closely applied to the break and apparently acts like a pump; suction of the contents is also possible by means of the grooved maxillae, the ends of which are applied together, forming a tube. I never succeeded in seeing the maxillae penetrating into the grain; they are apparently very slender and not visible through the cell wall. The maxillae could be introduced through the opening made by the mandible. As the pollen grain is sucked out it becomes filled with air which enters through pores in the cell wall. These grains which have been sucked out become wrinkled and lose their shape after a while. Aside from the two methods indicated above, yet a third way of feeding is often observed: the thrips makes a puncture in the pollen grain and then quickly abandons it or even holds on to it for a long time, but in this case neither a flattening of the grain nor a change in its color occurs. Evidently these punctures are made by replete thrips which do not imbibe the plasmatic contents of the cell or which do not suck it completely dry. The sucking out of the pollen grain proceeds quickly, lasting from 2 to 10 seconds, sometimes 15-20 seconds, depending on the size of the grain, the species of thrips, and the air temperature.

Thrips larvae of all instars also feed on pollen.

It is easier to carry out observations on the larvae since they are less mobile and more voracious than the adults. The larvae may be transferred from old, dried up flowers into fresh ones and thus larger concentrations may be obtained in a single flower, something which considerably facilitates observation. Under highly congested conditions cannibalism is observed among the larvae.

Observations on the feeding of thrips require a lot of time. Only by sitting at the microscope continuously for several hours is it possible to obtain a true picture of the nature of their feeding habits. Replete thrips either remain immobile, rarely moving to a new location, or run around inside the flower in a lively manner. The intervals between feeding may be lengthy. While feeding the thrips suck out several grains one after the other, sometimes 20 or 30, depending on the size of the grains, the species, and the condition of the thrips. All this

means that only rarely does one catch a feeding thrips in the field of vision. Even then the thrips must be oriented in such a manner that it can be seen from the side and in profile, so that the pollen grain is not hidden by parts of the flower or by the forelegs. The illumination of the subject is very important; a clear picture is obtained only if sunlight falls on the pollen grain. It is very rare for all these favorable circumstances to coincide.

Observations showed that the thrips concentrated in flowers with ripe anthers in which the walls of the corolla bore much pollen. There were always fewer thrips in flowers with unopened anthers. Feeding of the thrips occurs almost entirely at the expense of the contents of the pollen grains. However, it should be mentioned that the thrips can make punctures in the flower tissue and feed on the juices of the latter. This often occurs in young flowers with unopened anthers. Sometimes one may observe the thrips drinking nectar by pushing the end of the mouthparts into a drop of nectar.

Observations were made on the following species of thrips which are most frequently encountered on flowers (determinations by N. N. Derbeneva):

Suborder Terbrantia

1) *Aeolothrips fasciatus* L.
2) *Odontothrips loti adustus* Priesner.
3) *Odontothrips loti loti* Haliday.
4) *Oxythrips brevistylis brevistylis* Trybom
5) *Taeniothrips atratus atratus* Haliday.
6) *Thrips physopus* L.
7) *Thrips tabaci* Lind.

Suborder Tubulifera

8) *Haplothrips angusticornis* Priesner.
9) *Haplothrips niger* Osborn.

Since all the species investigated fed on pollen, the general conclusion may be made that all thrips found in flowers feed on the liquid plasmatic contents of pollen grains.

The Origin of the Asymmetrical Mouthparts of Thrips

The structure of the mouthparts is of great interest in the study of thrips, since it is quite unique. The structure of thrips' mouthparts has been described in detail in basic texts on entomology (Shvanvich, 1949; Grassé, 1951; Obenberger, 1955), hence I will not discuss it.

The evolution of the mouthparts of thrips, like those of other insects, proceeded under the direct influence of the mode of feeding. The mouthparts of thrips are sharply distinct from the piercing-sucking apparatus of other groups of insects; the disappearance of one mandible, from which the asymmetry of the entire oral cone originated, is particularly enigmatical. Many authors have remarked upon the mysteriousness of this phenomenon (which is unique among insects), but no one has attempted to explain it.

An explanation of the structure of the mouthparts of thrips is possible by taking into account the peculiarity of their feeding habits, in particular their pollen feeding. Pollen is distinguished by its infinitesimally small size. The diameter of pollen grains in most flowers varies from 20 to 40 microns; only in a few flowers does it attain 100 or more microns (cucurbits, Malvaceae, etc). If pollen is available to insects with chewing mouthparts and can occupy an important place in the regime of several groups, among the sucking insects which feed on plant juices there is no possibility of sucking out pollen grains because of the small size of the latter. The piercing-sucking apparatus of insects is too coarse to extract the liquid contents of pollen. Even such minute sucking insects as plant lice could not feed on the contents of pollen.

The structure of the mouthparts of thrips may be understood by taking into account the fact that the pollen fed on has a negligibly small surface to be punctured. On closer study it appears that the mouthparts of thrips possess features evidently adapted for the sucking out of pollen grains. The features showing adaptive characteristics are presented below.

One of the characteristic features of the mouth organs of thrips is the asynchronous (not simultaneous) action

of their parts. The maxillae and mandibles may function alternately, not simultaneously. Apparently the single mandible makes the puncture in the outer wall of the pollen grain. Several authors (Jordan, 1888; Peterson, 1915; Reyne, 1927) believe that the mandible serves to pierce tissues, after which it is retracted into the oral cone and the maxillae are introduced into the same wound, serving to imbibe the sap. This is clearly indicative of adaptation, since in order to use the stylets synchronously all three of them would have to be introduced simultaneously. With the small size of the pollen grains this would be serious. From the above it begins to be understandable why sucking out pollen grains is impossible for other sucking insects. When activity is synchronous the stylets of the mouthparts are introduced simultaneously into the tissues of the plant or animal; the Hemiptera and Homoptera have 4 stylets (two mandibles and two maxillae) and the mosquitoes have 6 (the pairs of maxillae and mandibles, the hypopharynx, and labrum). This many stylets, no matter how fine, could not be introduced into a pollen grain.

In thrips, where the action of the stylets is asynchronous, the number of the latter participating in the puncturing of the pollen wall is reduced to a minimum and consists of one mandible. The two maxillae may also be introduced, but this is not obligatory, since the sucking out of the grain may also occur through the single puncture caused by the mandible. When feeding thrips are anaesthetized with chloroform the mandible often protrudes from the oral cone for a lesser distance in the Terebrantia and a considerable distance in the Tubulifera. This also suggests the use of asynchronous action in the mouthparts of thrips.

Reyne (1927) found that of 40 punctures in leaf tissue, 17 consisted of just one puncture in a cell, 16 consisted of two punctures, and 7 consisted of three. The author suggested that in the latter case all three stylets were pushed in separately. Both Peterson (1915) and Reyne (1927) believe that the puncturing of the leaf tissue takes place principally with the mandible, as the strongest stylet, while the weaker, grooved maxillae are introduced into the prepared opening together with the mandible and then suck up the contents of the cell. To this it must be added that pollen has a thicker wall than the leaf epidermis, and it is therefore probable that the maxillae, as the slenderest and weakest structures, cannot always penetrate it. The probability increases that the puncturing action is predominantly by the mandible during feeding on pollen. The wall of the pollen grain possesses great strength; it is not broken down by the action of the digestive juices of the insect, it is not subject to the influence of climatic factors, and it is preserved in the fossil state. In many plants the wall of the pollen grain bears structural formations in the form of spines which strengthen it even more and impede its penetration by the insect. All this makes it extremely probable that the pollen cell wall is punctured by the mandible exclusively.

Thus, the asynchronous action of the stylets in thrips and the atrophy of one mandible can be regarded as adaptations to the penetration of the thick wall of pollen grains, which have a negligibly small surface area to be punctured.

The ancestors of the thrips undoubtedly had two mandibles. During the process of evolution, atrophy of the right mandible occurred; its vestiges may be seen in the members of the more primitive group (the Terebrantia), whereas in the younger group (the Tubulifera) it has disappeared entirely. Atrophy of one mandible caused asymmetry in the entire oral apparatus of thrips. The process of atrophy of one mandible could apparently have occurred in the following manner. In order to feed on the contents of pollen grains only one mandible could function, because of the negligibly small surface area to be punctured, and consequently the thrips acquired the ability to work the mandibles alternately. The puncture was made by only one mandible while the second one was inactive and atrophied.

The reduction in the number of piercing components in the mouthparts of thrips could only be advantageous for feeding on pollen of very small size. For feeding on the juices of plants or animals atrophy of one mandible could not be advantageous and, consequently, could not have taken place, since the surface to be punctured in these cases was not limited. The reduction of one mandible for feeding on pollen is advantageous and biologically justified.

During the process of thrips evolution, differentiation and change in feeding habits occurred, with consequent possible changes in the mouthparts. The continuing evolution in maxillary structure in thrips should be pointed out. Each maxilla has a groove in the piercing component; applied together they form a tube which serves for sucking in the nutritive fluid. Priesner (cited in Reyne, 1927) determined that many members of the suborder Tubulifera contained food consisting of algae and fungal spores in the gut. This applies particularly to species which live under bark and in forest litter. Feeding on algae and fungal spores is a widespread habit among

the members of the family Phloeothripidae. This shows that many representatives of the suborder Tubulifera are able to suck in solid particles through the maxillae. Reyne (1927) investigated the mouthparts of thrips which feed on algae and fungas spores. In these thrips (Dinothrips sumariensis from Java was examined) the maxillae differ from those of the Terebrantia. The groove-like maxillae are broader, and the tube formed by them has a large diameter, while the ends of the maxillae are excised to allow passage into them of spores and algae. They are able to ingest solid food particles 10-30 microns in diameter. In Liothrips sp. the maxillae have a very complicated structure for raking in spores, which are directed into the widened and cup-like hypopharynx. It is not impossible that with further investigations species will be found which are able to ingest the minute pollen of flowers.

Since all thrips have basically the same mouthparts, adapted for sucking out pollen grains, we may postulate that in the past their main diet consisted of pollen. Until the success of the angiosperms, which occurred in the middle of the Cretaceous, the thrips could have fed on gymnosperm pollen and spores. The evolution of all the thrips in our fauna apparently occurred through pollen feeding. The transferral to feeding on plant juices must be regarded as a secondary event which originated as a result of further differentiation and specialization of individual representatives of this group.

Apparently the original mode of feeding of thrips must be considered to have been the predatory one, since the members of the most primitive family — the Aeolothripidae — are predators. Among the extinct forms members of this family predominate (Ion, 1928); they are distinguished by a more complete wing venation and a greater number of antennal segments. But since the Aeolothripidae feed on pollen as well as animal food, the former diet could be considered very ancient, as ancient, possibly, as predation. In favor of the great antiquity of pollen feeding is the fact that it determined the course of evolution of the mouthparts. Predation, as we have already discussed, cannot lead to the atrophy of one mandible, since this could render no sort of advantage in feeding on animal fluids. In food value pollen occupies an intermediate position between animals and plants, and may serve as an intermediate link in the transition to feeding on plant juices.

We can imagine the course of evolution in feeding habits in the following manner: predation — pollen feeding — feeding on plant juices — ingestion of algae and fungus spores (the latter in only a portion of the Tubulifera). The more primitive group is the suborder Terebrantia. The following characteristics demonstrate their greater primitiveness in comparison with the Tubulifera: the presence of vestiges of the right mandible, more complete venation, an ovipositor, oviposition in plant tissue, and more antennal and palpal segments. The modification of the maxillae in a large proportion of the Tubulifera and their ability to ingest minute solid particles in the form of algae and fungal spores must be regarded as secondary phenomena which arose during the later stages of evolution.

SUMMARY

Flower inhabiting thrips suck out the liquid contents of pollen, this being their primary food. More rarely they feed on the juices of the flower and on nectar.

The asynchronous (nonsimultaneous) action of the mouthparts of thrips and the reduction of one mandible may be regarded as adaptations to sucking out the fluid contents of pollen grains, which possess a thick outer wall and a negligibly small surface area to be penetrated. As a result, the number of stylets participating simultaneously in the puncturing of the outer wall of the pollen grain has been reduced to the absolute minimum and consists of only one mandible. After penetration of the outer wall of the pollen the mandible is retracted into the oral cone, the latter is closely applied to the break and sucks up the contents of the pollen grain, the outer wall of which then usually flattens out. The two grooved maxillae which together form a tube may also be introduced into the prepared opening previously made by the mandible and suck out the contents of the pollen; in this case the outer wall of the latter retains its original form. The pollen grain has a thick cell wall and consequently the maxillae are unable to penetrate it.

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A DESCRIPTION OF LARVAE OF THE CASSIDINAE (COLEOPTERA, CHRYSOMELIDAE) BELONGING TO EUROPEAN USSR, TOGETHER WITH CERTAIN FEATURES OF THEIR BIOLOGY AND ECOLOGY

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Leaf beetles of the subfamily Cassidinae constitute a somewhat isolated group, whose members show a uniformity of structure and bionomics; the subfamily is poor in species (at least in temperate regions), in the European parts of the USSR and neighboring countires there are about 40 different kinds.

All the Palearctic Cassidinae are insects which live and feed upon herbaceous plants. They feed on plants belonging to relatively few families, among which may be mentioned specially the Compositae, Labiatae, Caryophyllaceae, Chenopodiaceae and Convolvulaceae.

The Cassidinae are highly specialized insects, of considerable interest to the student of zoogeography, ecology and taxicology. Certain species,e.g., Cassida nebulosa L. and C. nobilis L. (Zverozomb-Zubovskii, 1956) are secondarily predators of sugar-beet; other species are almost monophagous and by virtue of their feeding on weeds are of use to the arable farmer, the nurseryman and those concerned in grassland management – to this latter group belongs C. murraea, C. viridis, C. sanguinosa, Hypocassida subferruginea, (Palii, 1957).

The authors have made a study of those Cassidinae which occur in the Central, Black-Earth Regions of the RSFSR and parts of northern Ukraine, principally in basins of the Rivers Seim, Don and Donets. Here, about 20 species of cassidinid beetles occur, of which 12 are common: Hypocassida subferruginea Schrank., Cassida nebulosa L., C. rubiginosa Müll., C. prasina Ill., C. nobilis , C. murraea L., C. viridis L., C. stigmatica Suffr., C. sanguinosa Suffr., C. denticollis Suffr., C. vibex L., C. lineola Creutz.(Palii, 1957). In the author's recent paper (1959), there is a short description given of the ecology and biology of the Cassidinae from the above region, together with a description of their pupae.

In a further study of the group our interest has been focused on the larval forms, of which a short description is given below. All the descriptions are based on living specimens, which have been bred and reared in the laboratory and which may be compared with examples captured in the field.

Larval Cassidinae throughout the Central Black-Earth Regions of the USSR live openly on plants, particularly on the lower surface of leaves, less frequently on stems (e.g., C. lineola feeds on the stems of Artemisia scoparia, C. prasina and C. denticollis are sometimes found feeding on the stem of Achillea millefolium and C. viridis may occur very occasionally on the stems of Stachys and Mentha). Larvae of all instars skeletonize leaves, usually leaving the upper epidermis intact. We have discussed the food relationships of the Cassidinae in an earlier paper (Palii, 1957).

The larvae of the majority of species bend the anal extremity of the body up and over their backs and in this way become covered with their own excrement, a device which evidently protects them from predators.

During the course of its life the larva usually molts twice (the third ecdysis being the pupal one); consequently there are 3 larval instars. In C. viridis and C. sanguinosa, possibly also in C. murraea, there appear to be 4 larval instars. Practically all Cassidinid larvae are mesophilous, with a tendency toward hygrophily.

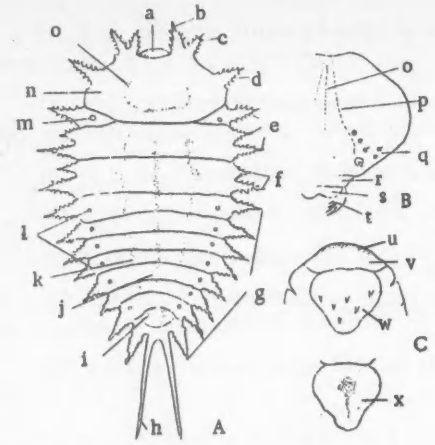

Fig. 1. Structure of a larva belonging to the Cassidinae: A) general view of larva: a) head; b) inner pronotal process; c) outer pronotal process; d) lateral pronotal process; e) mesonotal processes; f) postnotal process; g) processes of abdominal segments; h) caudal filament; i) dorsal part of 8th abdominal segment; j) median dorsal line; k) lateral dorsal line; l) abdominal spiracles; m) thoracic spiracle; n) pronotal shield; B) head of larva: o) median frontal suture; p) lateral (genal) suture; q) ocelli; r) clypeus; s) labrum; t) mandible; C) anal appendage: u) base; v) basal sclerite; w) apical sclerite; x) anal aperture.

C. lineola and C. pannonica are more xerophilous than the others. In the dry steppes and semisteppeland of European USSR, chrysomelid beetles have occasionally been observed on the wing but in all probabilities these were isolated examples which had migrated over considerable distances to where they were seen and did not breed there. The author has never been able to find chrysomelid larvae in steppe or semidesert conditions.

C. murraea, C. viridis and C. sanguinosa are rather more hygrophilous than most other species. They prefer to breed in meadows and on the outskirts of woodland, but on rare occasions their larvae have been found on swampy grassland.

Cassidinid larvae may be found at the end of spring and during the first half of the summer. In almost all species throughout the zone the larvae emerge from the end of May until the middle of June, and the larval phase lasts until early July; it is unusual to come across a chrysomelid larva after the 20th of that month. At a mean daily temperature of from 17 to 21°, the larval phase of the life cycle lasts from 18-24 days.

Cassidinid larvae are most numerous and diverse in meadow land where the vegetation is composed of several different species of grass and includes ruderal plant species; such conditions occur most frequently where the land has been disturbed by man or such mammals as moles, suslike or marmots. Here the following are very abundant: C. nebulosa, C. nobilis, C. rubiginosa, C. vibex, C. denticollis, C. stigmatica, C. lineola, H. subferruginea. In damper localities on the outskirts of woodland and in wet fields C. viridis and C. prasina are the species most frequently encountered. In really damp meadowland on the banks of rivers C. murraea is most abundant, often occurring in considerable numbers; C. sanguinosa is more rarely found.

The structure of cassidinid larvae is very characteristic; in order to facilitate their identification there is given the following general description of larvae belonging to this group.

Larval body dorsoventrally compressed, oval and elongated to various degrees in different species (Fig. 1A). Head usually invisible from above, bent underneath the thorax, transversely expanded, almost hemispherical but more strongly convex laterally; well-developed clypeus and extremely well-developed labrum of semicircular or elliptical form with a terminal indentation. Mandibles well developed, bearing sharp toothlets on their internal margins, or instead bearing oval projections (C. lineola). Above the clypeus and to the side of it, there usually arise 3-jointed antennae, each having a large, slightly compressed basal segment, followed by somewhat tapering, cylindrical second and third segments. On each side of the head 5-8 black, simple ocelli occur in a ventral position.

The pronotum is strongly compressed from front to back and tapers anteriorly; it is markedly convex at the side; the pronotal shield bears an obvious pattern and is armed with a limited number of spinules or tubercles, the front margin is straight or slightly convex, but laterally there arise 2 more or less large outgrowths — the pronotal processes; another process occurs in the middle of the lateral margin of the pronotum. Lateral to the pronotum lie 2 triangular sclerites; these do not attain the midline of the pronotal shield but each bears a single spiracle and process. The mesothorax and metathorax are strongly compressed from front to back; their anterior and posterior margins are parallel. Each bears a pair of processes laterally, the anterior member of the pair being smaller than the posterior. There are no spiracles on the meso- and metathoracic segments.

The abdomen is conical, with its upper surface flat. The first abdominal segment is wider and straighter than the subsequent segments which are more or less convex basally. Each abdominal segment from 1-7 has a single pair of spiracles situated laterally. The spiracles often occur on more or less elongate tubules — the stigmatal papillae. An abdominal process arises from each side of the abdominal segments. The anal segment is rounded dorsally and bears a pair of relatively long filaments. The anal aperture is situated ventrally on the projecting anal appendage.

Indentification Key for Cassidinid Larvae

1 (22) Five ocelli present on each side of the head, near to the base of the antennae.

2 (3) Lateral processes of abdomen markedly different sizes: those on segments 1-5 short, equal in size or decreasing slightly toward the head end; those on segments 6-8 considerably longer. Labrum short but wide, with a deep terminal notch. Caudal filaments very long, widely separated at the base. Anal appendage with hemispherical base and triangular anal aperture.

Larvae occur from middle of May to middle of June on the outskirts of woodland and parkland, less frequently in dry meadows and waste land; they feed on yarrow (Achillea millefolium), more rarely on tansy (Tanacetum vulgare) . . . . . 1) Cassida prasina Ill.

3 (2) Lateral processes of abdomen of similar size or there is a gradual change in length, particularly from the 6th-8th segments. Labrum and anal appendage of different structure to those of last species and variable; caudal filaments confluent at their bases or very near together.

4 (5) Internal pronotal process longer than the external. All the processes small, with feebly developed spinules, abbreviate-conical.

Larvae are to be found mainly on tansy from the end of May to the beginning of July on the outskirts of woods, in fields and waste ground . . . . . 2) Cassida stigmatica Suffr.

5 (4) Internal pronotal processes equal to or shorter than the external pronotal processes. Processes elongate, lanceolate or awl-shaped, usually bearing numerous large lateral spinules.

6 (17) The pronotal shield bears a pattern formed from small spinules; grooves or wrinkles may or may not add to this pattern.

7 (10) The pattern on the pronotal shield is a single entity, i.e., not separated into 2 symmetrical lateral figures but united as a general basal or terminal figure.

8 (9) The pattern on the pronotal shield is formed from wrinkles and depressions, supplemented by black spinules; it is in the form of an inverted lyre. Spiracles black in color.

Larbae occur from the middle of May to the beginning of July on Canada thistle (Lappa) in fields, wasteland and meadows. . . . . 3) Cassida rubiginosa Müll.

9 (8) Pattern on pronotal shield is elliptical; its figure is completely closed at the apex and base. Spiracles white.

Larvae occur from the beginning of June almost to the end of July on cornflowers, particularly on Centaurea scabiosa, in wooded parkland, in dry meadows and the outskirts of woods where the soil is dry . . . . . 4) Cassida vibex L.

10 (7) Pattern on pronotal shield consists of 2 laterally placed symmetrical figures, which are not joined by any continuous line at base or apex of shield; any continuous line at base or apex is distinct and separate from the 2 figures.

11 (16) Lateral notal and abdominal processes are lanceolate, acutely conical, more or less transparent, with elongate, lateral spinules lying almost at right angles to the longitudinal axis of the process.

12 (15) Anal appendage caudal or in the form of a rounded cone, with uniradiate anal aperture.

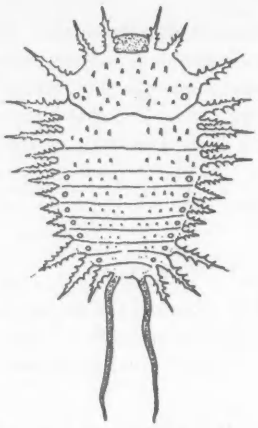

Fig. 2. Cassida prasina Ill. General view of larva.

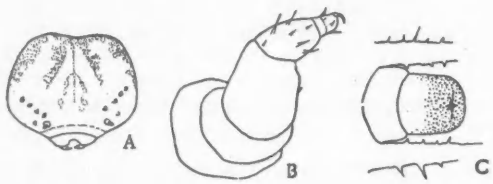

Fig. 3. Cassida prasina Ill. Larva: A) head; B) anterior limbs; C) anal appendage.

13 (14) Pattern on pronotal shield consists of 2 large circles which extend to the lateral edges of the shield and cover almost the whole of its area. Spiracles on abdominal segments black. Caudal filaments are spinous at the base. Internal apical process of pronotum is sometimes directed outward to a slight degree.

Larvae are found from the beginning of June to the second half of July feeding almost exclusively on sneezewort (Ptarmica vulgaris) in wet meadows, water meadows and swampy grassland . . . . . 5) Cassida sanguinosa Suffr.

14 (13) Pattern on pronotal shield consists of 2 small, more or less exact circular areas, delimited by wrinkles. Spiracles all white. Caudal filaments without spinules.

Larvae from the middle of May to the middle of June on tansy, or more rarely on yarrow (Achillea) in dry meadows, waste ground, rarely in wooded parkland . . . . . 6) Cassida denticollis Suffr.

15 (12) Anal appendage cylindrical, slightly fungiform and expanded at the apex, or in the form of a truncate cone; anal aperture triradiate. Body wide, ovoid, with very long caudal filaments which are almost confluent at the base. Pattern on pronotum composed of wrinkles and resembles a helicoid spiral. Mandible with 5 long, pointed toothlets, which increase in size from base to apex.

Larvae found from the end of May to the beginning of September on white goosefoot (Chenopodium album) and on beet in fields and waste ground . . . . . 7) Cassida nebulosa L.

16 (11) Lateral notal and abdominal processes awl-shaped, not transparent, black or dark brown, with short spinules lying at acute angles to the longitudinal axis. Abdominal processes more or less claw-like and directed ventrally; pronotal processes smaller than those of abdomen. Pattern on pronotum consists of 2 separate circles and a common fold which runs parallel with the base of the shield. Mandible with 5 small rounded teeth, all the same size.

Larvae occur from the beginning of June to the second half of July, mainly on wormwood (Artemisia scoparia) in dry, sandy meadows, steppe-meadows and in pine plantations on sandy soil . . . . . 8) Cassida lineola Creutz.

17 (16) No pattern of wrinkles or spinules on pronotum; if the pronotum is covered with spinules then they are arranged in an irregular fashion.

18 (19) Pronotal shield covered with rather large spinules arranged in an irregular fashion. Caudal filaments confluent at the base and strongly thickened in this region. Apical area of terminal segment devoid of spinules.

Larvae occur in June and July, sometimes during the first half of August on beet, goosegrass and orache (Atriplex) in fields, waste ground and dry meadows. . . . . 9) Cassida nobilis L.

19 (18) Pronotal shield not covered with large spinules. Caudal filaments not confluent at the base, but with the bases in close proximity. Backwardly directed spinules occur at the apex of the terminal abdominal tergite.

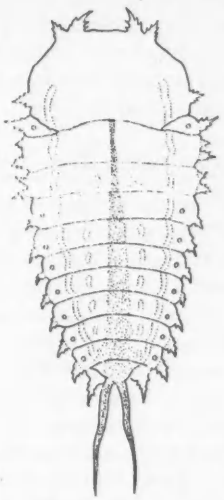

Fig. 4. Cassida stigmatica Suffr. General view of larva.

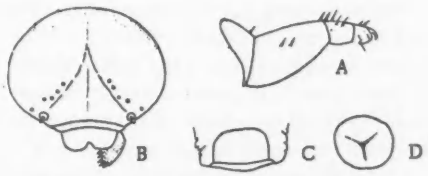

Fig. 5. Cassida stigmatica Surrf. Larva: A) head; B) limb; C) anal appendage; (lateral view; D) same, from above.

20 (21) Apical processes of the pronotum are more or less equal in size. Anal appendage in the form of a rounded cone with an elongate, uniradiate anal aperture. Caudal filaments relatively short, slightly curved outward. The median toothlets of the mandibles are the largest.

Larvae occur from the middle of May to the beginning of July on sage (Salvia), mint (Mentha) and woundwort (Stachys) in woodland and shady places ..... 10) Cassida viridis L.

21 (20) Internal apical processes of pronotum are somewhat shorter than the external. Anal appendage hemispherical at the apex. Caudal filaments slender, elongate and straight.

Larvae occur during June on fleabane (Inula britannica) in creeks and damp meadows..... 11) Cassida murraea L.

22 (1) On each side of the head, near to the base of the antennae are not less than 6 ocelli. Body abbreviate-oval, with large equal processes, with long caudal filaments having their bases in close proximity, with 2 helicoid, spinular patterns on the pronotum.

Larvae from the second half of June to the second half of August on field bindweed (Convolvulus arvensis) in fields and waste ground ..... 12) Hypocassida subferruginea Schmk.

Description of Cassidinid Larvae

1. Cassida prasina Ill. – The Yarrow Shield Beetle (Fig. 2)

The body is green with white spots dorsally, sides of body yellowish, lateral processes transparent. Thoracic and 6th and 7th and 8th abdominal segments smokey grey dorsally; caudal filaments usually black at the base, becoming lighter colored further along their length and transparent at the tip. Head salad-green, with diffuse black spots on the genae, frons and vertex; clypeus brownish. The underside is a uniform green color tending to become yellowish peripherally. Spiracles white. Approximate dimensions: length 3.8-4.2 mm , greatest width at the base of the pronotum up to 2.5 mm , caudal filaments up to 3.0 mm. Pronotum evenly rounded with a feebly developed hood, in consequence of which the base of the head, in dorsal aspect, appears broadly concave. Abdominal segments narrow, the first 6 with parallel edges, the 7th with convex anterior edge, the 8th without a dorsal eminence. Body short and depressed; from the pronotum as far as the 3rd abdominal segment, the 2 lateral margins of the abdomen are parallel, beyond that point the body gradually curves in to the posterior tip. The internal pronotal process is larger than the external.

Abdominal processes gradually decrease in size from 1-5; abdominal processes 6-8 are almost 3 times as large as the first processes. All the processes are straight and project at right angles to the body surface; processes 1-5 stick out laterally, processes 6-8 are directed posterolaterally. Caudal filaments are long (not less than half the length of the body) and curved somewhat in the shape of a lyre. Dorsal surface of body covered with transparent spinules which are irregularly dispersed over the pronotum but arranged in more or less regular rows over the remaining tergites; there are 3-8 spinules on each side of the tergites. Head (Fig. 3A) with an unbranched elongate depression along its length. Ocelli 5: 3 in number, arranged along the lateral margin of the genae, the 4th is nearest to the clypeus, the 5th lies to the outside of the base of the antenna. Clypeus narrow, labrum with a terminal notch which is both deep and wide. Anal appendage (Fig. 3C) 2-jointed, the first in the form of a short cylinder, the second joint is also cylindrical but has a rounded tip, studded with punctate tubercles.

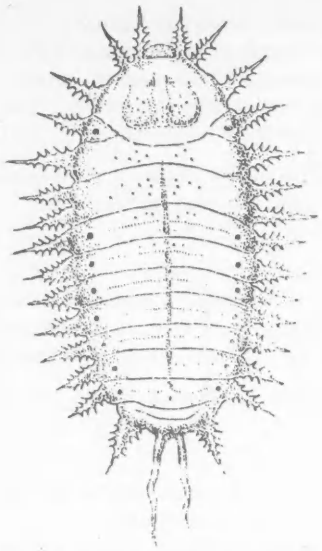

Fig. 6. Cassida rubiginosa Müll. General view of larva.

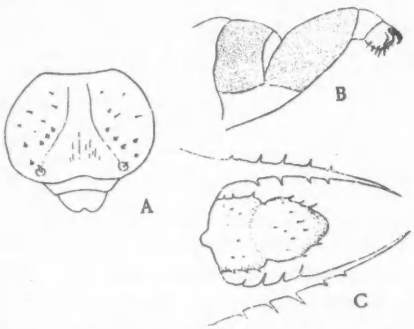

Fig. 7. Cassida rubiginosa Müll. Larva: A) head; B) posterior limb; C) anal appendage.

Anal aperture vaguely triangular. Abdomen and metathorax studded with rather long, thick spinules which are green with lighter colored tips; single, somewhat longer spinules occur on the femora, together with stout spinules on the tibiae and single spinules on the tarsi.

2. Cassida stigmatica Suffr. – Tansy Shield Beetle (Fig. 4)

Coloration: dorsally the body is bright green, with a median stripe of grey-green beginning at the back of the pronotum and gradually widening toward the anal segment. To the side of this strip are white comma-like spots; above the line of spiracles a continuous white strip runs from the pronotum to the 7th abdominal segment down each side of the body. Spiracles white. Lateral processes of the body green, but of a lighter shade than that of the body itself; caudal filaments black. Head bright salad-green with a marbled grey pattern on the vertex. Base of antennae edged with green but from the second segment to the tip the antennae are black. Clypeus grey-green; labrum and mandibles blackish brown. Body form elongately ovoid with greatest width at the level of the pronotum. Dimensions: length up to 7 mm , thorax up to 2.0 mm , lateral processes 0.2-0.3 mm, caudal filaments up to 2.4 mm. Pronotum sharply truncate at the front, slightly obtuse-angled laterally and saddle-shaped at the back; anal segment triangular. Lateral processes very short, broadly awl-shaped. Inner apical process of pronotum claw-like and curved inward , significantly larger than the outer process. The third pair of processes are significantly smaller than the first 2 pairs. Processes of pro-, meso- and metathorax (apart from the first 2 pairs) are short and directed laterally. Processes of the first 6 abdominal segments are small, claw-like and directed posteriorly, whereas processes of abdominal segments 7 and 8 are rather longer, but again directed posteriorly. The processes bear 1-3 small toothlets on both sides. Caudal filaments long, closely approximated at the base, slightly bent into lyre-shaped curves. Head (Fig. 5A) with very faint frontal sutures and median groove. Ocelli arranged in the usual fashion (as in C. prasina). Clypeus very narrow and elongate; labrum wide, trapeziform with a distinct notch at its apex. Mandible like a long hatchet in shape, with 5 toothlets of which the 2 inner ones are smaller than the 3 outer ones. Limbs (Fig. 5B) with a long, narrow femur and a tibia in the form of a truncate cone. Anal appendage (Fig. 5C) arises from a very slightly indented base and is 2-jointed. First joint is flat and depressed, the second is in the form of a short cylinder with a triangular anal aperture which lies centrally in the circular, flat tip (Fig. 5D).

3. Cassida rubiginosa Müll. – The Green Thistle Shield Beetle (Fig. 6)

Coloration: upper parts greyish green with rows of black spinules on the abdomen and irregularly scattered spinules on the meso- and postnota. Base of lateral processes black, body of processes brownish as are also the caudal filaments. Spinules on the lateral processes are transparent. There is a lyre-shaped erection on the pronotum formed from small, short spinules. Head and spiracles black. Underside a dirty greenish color, dorsal surface of femur and tibia grey due to masses of small, black granules. Anal appendage smokey black. Shape of body is elongate-oval, rather more drawn out at its posterior end and more rounded anteriorly. Length up to 8 mm , greatest width up to 3.5 mm , caudal filament up to 2 mm , processes to 1.0-1.4 mm. Pronotum uniformly curved at the front, convex posteriorly.

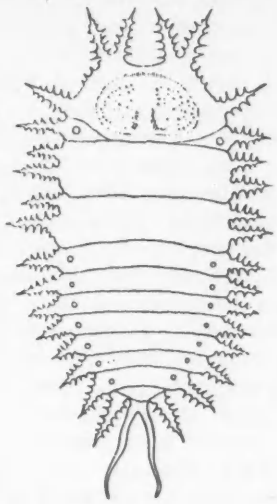

Fig. 8. Cassida vibex L. General view of larva.

Meso- and metathoracic segments and first 6 abdominal segments with parallel-sided tergites, the 7th abdominal tergite with a convex posterior margin. Processes all of approximately equal length, projecting laterally, straight, awl-shaped. Four spinules occur on each side of every process. Caudal filaments closely approximated at the base, projecting in a lyre-shape, each slightly curved in the middle. Head (Fig. 7A) with indistinct frontal sutures; there is no median groove. Antennae and eyes normal. Frons and clypeus noticeably bent into saddle-shaped structures; labrum wide, curved with a small indentation. Genae strewn with a few dark colored setules. Anal appendage (Fig. 7C) 2-jointed the first joint cylindrical, the second broad at the base with the apex tapering in a heart-shaped fashion, completely covered with black spinules and at the tip with black granules.

4. Cassida vibex L. – The Cornflower Shield Beetle (Fig. 8)

Coloration: upper side of body grass-green with light greenish-brown ringlets on the posterior pronotum. On the upper side of the body, particularly along the midline, yellow, irregular dots are scattered. The black spinules of the pronotum form an oval figure lying transversely. Spiracles white. Head greenish grey; clypeus, labrum and mandible dark brown.

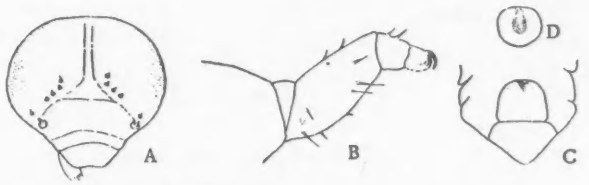

Fig. 9. Cassida vibex L. Larva: A) head; B) limb; C) anal appendage (side view); D) same, from above.

Body oval-shaped with a rounded head end and elongate caudal extremity. Greatest width at about the middle. Length up to 6.7-7.0 mm , greatest width 2.9-3.0 mm , lateral processes 0.6-0.9 mm, caudal filaments 2.0-2.2 mm. Pronotum noticeably indented at the front between the apical processes, straight at the sides. The area on the pronotum which is delimited by spinules has many very large pores distributed over it. Posterior margin, of pronotum straight, meso- and metathoracic tergites together with tergites 1-7 of abdomen have parallel anterior and posterior margins, the 8th abdominal segment is broadly saddle-like and triangular in outline. Lateral processes awl-shaped and all of approximately the same length, each with 4-5 large spinules on each side. Spinules of adjacent processes often touching and sometimes crossing over each other. All the processes are straight and directed approximately at right angles to the body surface. Caudal filaments confluent at the base, slender, elongate slightly bent into lyre-shaped curves. Head (Fig. 9A) with clearly discernible elongate sutures and a distinct transverse furrow. Vertex with large and obvious pits. Clypeus narrow, curved. Labrum large, trapeziform, with a very faint indentation on its anterior surface. Mandible with 5 pointed toothlets, of which the outer and inner ones are smallest and the middle one is the longest. Antennae and ocellii normal. Anal appendage (Fig. 9C) lies in a triangular depression; usually it is very short and it is 2-jointed. Basal joint broadly truncate-conical; the terminal joint almost spherical, although somewhat dorsoventrally compressed. Anal field delimited by raised border; the anal aperture is large and elongate.

5. Cassida sanguinosa Suffr. – Marsh Sneezewort Shield Beetle (Fig. 10)

Coloration: upper surface smokey grey, lighter colored centrally, darker at the sides. Lateral processes distinctly bicolored; the basal third black, the apical part brown. Caudal filaments colored similarly. Thoracic spiracles white, abdominal spiracles black. Head a uniform grey. Body covered with a few black granules regularly arranged in rows. Body elliptical, rather elongate with the greatest width in the middle of the thoracic

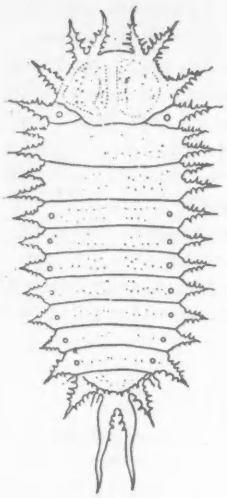

Fig. 10. Cassida sanguinosa Suffr. General view of larva.

region. Length up to 7.5 mm, greatest width up to 2.8 mm, processes 0.6-9.8 mm, caudal filaments 0.9 mm. Pronotum evenly rounded, with a wavy posterior margin. Pronotal shield with an elongate keel and 2 circular areas somewhat extended laterally delimited by furrows. Meso-, metathoracic and segments 1-7 of abdomen with parallel margins, the 8th segment approximately triangular with a rounded apex; on each side of the 8th segment are 4-6 strongly developed but short spinules. Several soft, elongate hairs occur in the region of the 7th and 8th abdominal segments at the base of the caudal filaments. Internal apical processes of prothorax are often claw-like and curved outward. Thoracic processes elongate and awl-like, abdominal processes elongate, somewhat compressed; all processes of approximately equal length, with only a slight decrease in size between the front one and the back, processes directed laterally, each bearing 3-6 spinules along its sides. Caudal filaments strongly confluent at the base, thick, short and bent into lyre-shaped curves. Head (Fig. 11A) with convergent, well-developed frontal sutures and a feebly developed median furrow. First pair of ocelli somewhat separate from the rest and situates near the frontal sutures. Basal segments of antennae usually narrow. Clypeus faintly notched. Labrum broad, with a clearly discernible triangular notch. Limbs (Fig. 11B) slender, elongate with all joints cylindrical, narrowing slightly at the tips. Anal appendage (Fig. 11C, D) situated in a clear-cut indentation of the anal segment; its basal segment short and cylindrical, its apical segment conical and bearing short spinules. Anal aperture situated near the tip of the appendage, uniradiate, elongate.

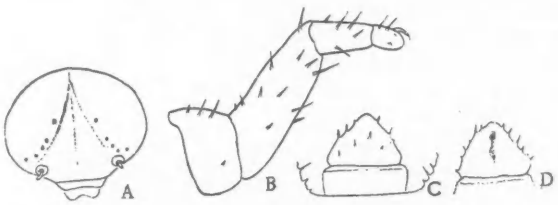

Fig. 11. Cassida sanguinosa Suffr. Larva: A) head; B) limb; C) anal appendage (lateral view); D) same, from above.

6. Cassida denticollis Surrf. – Yellow Tansy Shield Beetle (Fig. 12)

Coloration: body grass-green in color, stout. Lateral processes brownish with transparent spinules, caudal filaments brown. The dorsal surface of the body is covered with small, scattered black granules. Head grey-green; clypeus, labrum and mandible brown. Body elliptical, somewhat more tapering at the caudal end. Length up to 6.5 mm, greatest width, in region of metathorax, up to 3.2 mm, lateral processes up to 0.7-0.8 mm, caudal filaments up to 1.7 mm. Pronotum uniformly curved at the anterior end, convex between apical pronotal processes, straight along its posterior margin. Two lateral, indistinct figures delimited by furrows, occur on the pronotal shield; each figure is circular in outline with 3 radii. Mesothorax and metathorax wide, parallel sided. The abdominal segments decrease in width from the 1st to the 7th. Eighth abdominal segment acutely triangular with 3-4 spinules on its sides and 1 spinule, considerably longer than the others, at the apex. Laterally, the body is covered with small, scanty, green spinules; on the 7th abdominal segment, spinules also occur scantily along the posterior margin. Lateral processes are all of approximately equal size, awl-shaped with fine points, and covered with a very dense collection of equal-sized, setiform spinules. Caudal filaments close together at the base, swollen in the middle and bent in the form of a lyre. Head (Fig. 13A) with a distinct, median groove and indistinct frontal sutures which are almost confluent dorsally. Antennae and ocelli normal. Clypeus somewhat saddle-like. Labrum trapeziform, without any notch but with a transverse row of 4 spinules across its center. Mandibles with 4-6 toothlets which increase in size from the innermost to the outermost. The whole of the head is covered with elongate setules. Femur (Fig. 13B) very short and broad, with a proximal, bordering flange. Anal appendage (Fig. 13C) situated within a symmetrical notch of the anal segment. The basal segment of the

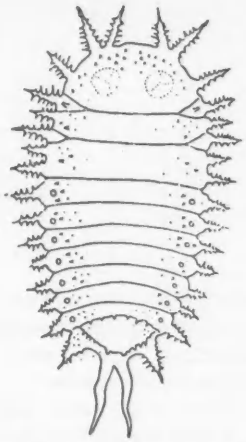

Fig. 12. Cassida denticollis Suffr. General view of larva.

appendage is elongately cylindrical the terminal segment is heart-shaped. Anal aperture (Fig. 13D) elongate, uniradiate. The terminal segment is covered with a few small spinules.

7. Cassida nebulosa L. – Beet Shield Beetle (Fig. 14)

Coloration: body colored salad-green, darker at the sides than in the middle; anal segment yellowish. All the lateral processes except the last 2 abdominal ones are white, transparent; the last 2 abdominal appendages are slightly brownish. Caudal filaments green at the base, further along they become light brown. Spiracles white. Head green, except for the vertex which is smokey grey. Labrum light brown, translucent, so that the strongly sclerotinized mandible shows through it. Body is ovoid with a broader cephalic end a more pointed anal end. Length up to 7.3 mm, greatest width (in pronotal region) up to 3.7 mm, lateral processes up to 0.8 mm, caudal filaments up to 3.1 mm. Pronotum has a straight anterior margin between the apical processes, it slopes outward to the lateral processes, and its posterior margin is saddle-shaped. Two figures occur laterally on the pronotal shield; they are delimited by furrows and are snail-like in appearance. Mesothorax and metathorax wide, straight and parallel sided. Abdominal segments gradually diminish in size from cephalic to

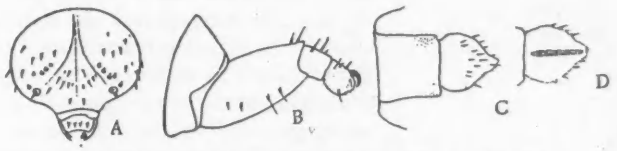

Fig. 13. Cassida denticollis Suffr. Larva: A) head; B) limb; C) anal appendage, from below ; D) same, from above.

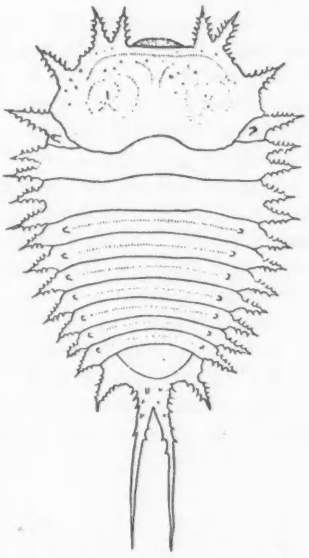

Fig. 14. Cassida nebulosa L. General view of larva.

caudal extremities. Anal segment hemispherical. Lateral processes all of approximately equal size, broadly awl-shaped, straight, directed laterally and bearing elongate, broad spinules, which in the second pair of pronotal processes are continued along the lateral margin of the pronotal shield. Caudal filaments very long, straight and almost fused together at the base, which is covered with a few scanty spinules. Head (Fig. 15A) with a distinct median groove and very indistinct frontal sutures. Antennae and ocelli normal. Clypeus narrow, straight; labrum broad, convex with a very slight indentation at the apex. Mandible with 3 definite toothlets, sometimes also bearing 2 small accessory toothlets, intermediate in position. Femur (Fig. 15B) short, in the form of an irregular truncate cone; tibia stout, somewhat convex on its abdominal side; faintly long 2-jointed tarsus. Anal appendage (Fig. 15C) set in a notch of the anal segment, apparently but not actually 3-jointed; the appendage consists of a basal projection from the anal segment, the true basal segment which is cylindrical and a somewhat mushroom-like terminal segment. On the vaguely spherical apex of the latter occurs the triradiate anal aperture.

8. Cassida lineola Creutz. – Golden Artemisia Shield Beetle (Fig. 16)

Coloration: body is a greyish golden color. Head, lateral processes and caudal filaments (excluding their white tips) from brownish grey to deep black in color. Spiracles white, surrounded by black. The pronotal figures are delimited by small spinules; there are larger

Fig. 15. Cassida nebulosa L. Larva: A) head; B) hind limb; C) anal appendage.

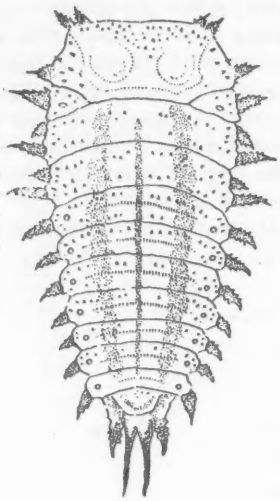

Fig. 16. Cassida lineola Creutz. General view of larva.

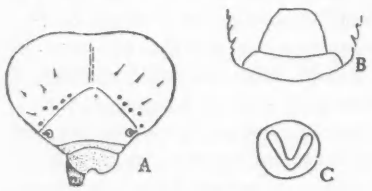

Fig. 17. Cassida lineola Creutz. Larva: A) head; B) anal appendage, lateral view ; C) same, from above

black spinules distributed over the whole of the dorsal surface of the body. From the side of the heart-shaped grey figures on the mesothorax extend 2 wide longitudinal stripes, which in larvae that have recently molted are grey but later become black. Abdomen and limbs are grey tending toward black, particularly at their extremities. Body ovoid with a flattened cephalic end and a more elongate, tapering caudal end. Length up to 7.5-7.9 mm, greatest width (at level of mesothorax) up to 3.4-3.6 mm, processes up to 0.6-0.7 mm, caudal filaments up to 1.0-1.3 mm. Pronotum with very widely separated apical processes, between which extends the faintly curved anterior margin; the sides of the pronotum slope outward and the posterior margin is slightly convex. On the pronotal shield are 2 areas delimited by spinules and surrounded by faint folds. Each figure consists of a rounded depression and lies to one side of the pronotum. Mesothorax and metathorax with parallel sides, convex anteriorally. Abdominal segments all of similar shape, but becoming progressively shorter toward the posterior end of the body, with transverse wrinkled folds. Eighth segment hemispherical. Processes: the 2 pairs of apical pronotal processes are small, conical and directed oblique-laterally; lateral pronotal processes larger, awl-shaped directed outward at right angles to the surface. The first and third pairs of mesothoracic processes are as described for the lateral pronotal processes, the second pair are, however, small, conical and directed posteriorly. Beginning with the second pair of metathoracic processes and passing backward through the abdominal series, the lateral processes are found to be short and stoutly awl-shaped, with claw-like, backwardly curved apices; the last 2 abdominal segments, however, bear straight, backwardly directed processes. Processes covered with black, small spinules. Caudal filaments confluent at the base, straight, strongly tapering in the middle. Head (Fig. 17A) with well-developed suture on vertex and triangular frontal sutures. Antennae and ocelli normal. A few scattered spinules on the genae. Clypeus narrow, slightly convex. Labrum proturberant, with a distinct, deep, rounded indentation on its apex. Mandible oval, with 5 rounded toothlets situated at its tip. Anal appendage (Fig. 17B) occurs within an opal notch. Basal segment short, broadly cylindrical; apical segment truncate-conical. Anal aperture V-shaped (Fig. 17C).

9. Cassida nobilis L. – Silver Chenopodium Shield Beetle (Fig. 18)

Coloration: body bluish green, processes faintly translucent, brownish with transparent spinules. Caudal filaments brownish. Spiracles white. Head light green with dark patches on the vertex, along the sutures and on the genae. Clypeus and labrum brownish and translucent. Body oval, rather more truncate at the head than

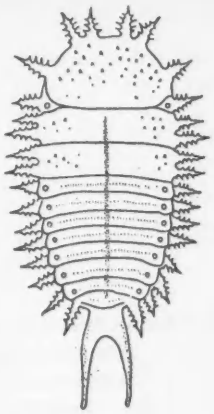

Fig. 18. Cassida nobilis L. General view of larva.

at the caudal extremity. The lateral processes point downward and their basal portions are covered by folds of the abdomen. The upper surface of the body is covered with irregularly distributed small spinules. Length up to 4.8-5 mm, greatest width (at level of mesothorax) up to 2.3 mm, processes up to 0.6 mm, caudal filaments up to 1.6 mm. Pronotum evenly rounded at the front, with its posterior margin straight. Mesothorax and metathorax wide, straight, parallel sided. Abdominal segments shorter than those of metathorax. Lateral processes all equal in length, set close together, straight, broadly awl-shaped, directed laterally. Caudal filaments confluent from their base over a fifth of their length, stout, straight. Head (Fig. 19A) with a faint median furrow; frontal suture separate from each other, indistinct. Ocelli and antennae normal. In the ocellar field there are 2 rows of rather long setules, 3 in each row. Clypeus narrow, straight, labrum wide, evenly curved. The mandibles can be seen through the translucent clypeus and labrum. Limbs (Fig. 19B) with short, wide femora each having a lateral notch and bearing a few long spinules. Tibiae straight with slightly curved ventral margins. Terminal joint of tarsus with a papillate spinule ventrally and a single, large spinule at base. Anal appendage (Fig. 19C) arises from an angular notch; its proximal segment is large, wide and shaped like a truncate-cone, as is the dorsal segment; the latter is however slightly expanded at the end, with

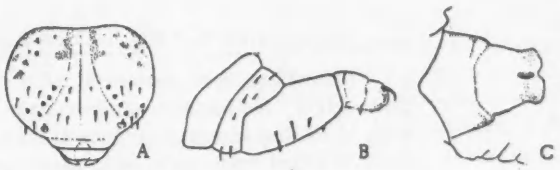

Fig. 19. Cassida nobilis L. Larva: A) head; B) limb; C) anal appendage, dorsal view.

an elongate cleft, in which lies the small, oval, uniradiate anal aperture. This distal segment is covered with punctate, warty granulations.

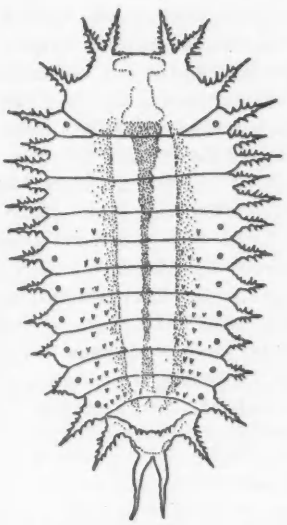

Fig. 20. Cassida viridis L. General view of larva.

10. Cassida viridis L. – Green Shield Beetle (Fig. 20)

Coloration: body grass-green with a grey dorsal line, on both sides of which are broad whitish stripes, bordered internally and externally with black. Lateral processes bright green, with transparent tips, slightly grey. Caudal filaments grey with a violet tinge. Spiracles white. Head green with black ocelli, brownish clypeus and translucent labrum. Distal third of mandible blackish brown. Body elongate-elliptical, with its greatest width in the region of the metathorax. Length up to 9 mm, width up to 4.1 mm, processes 0.5-1.1 mm, caudal filaments up to 1.6 mm. Pronotum straight anteriorly between the apical processes and also straight at the sides and along the posterior margin. Mesothorax and metathorax relatively narrow, straight, parallel sided. Abdominal segments approximately equal in length, the first almost straight, the posterior ones slightly curved. Anal segment broadly heart-shaped with 4 spinules on each side, arranged along the outer margin. On the sides of the other segments single or rows of spinules occur. There is a denser covering of long spinules on the ventral side of the body. Caudal filaments short, closely approximated at the base, somewhat curved like a lyre. Lateral processes awl-shaped, straight with 3-5 spinules on each side; processes more or less perpendicular to the body. Thoracic processes long and stout, abdominal processes shorter and more slender and situated on elongate-spherical outgrowths of the abdominal segments. Head

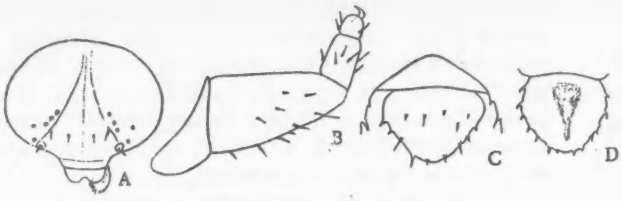

Fig. 21. Cassida viridis L. Larva: A) head; B) hind limb; C) anal appendage, from below ; D) same, from above.

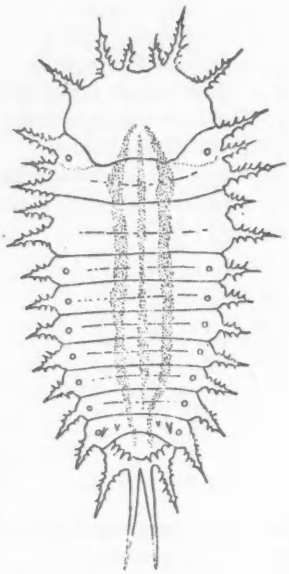

Fig. 22. Cassida murraea L. General view of larva.

(Fig. 21A) with a definite median furrow and less distinct frontal sutures. Clypeus narrow and shallow, slightly curved. Labrum deep, semicircular, with a distinct deep notch at its apex. Mandibles almost square, with 5 short equal sized spinules. Antennae and ocelli normal. Limbs (Fig. 21B) with short, tapering femora and rather long tarsi with a strongly projecting claw. Tibiae and tarsi covered with elongate, scanty setules. Anal appendage (Fig. 21C) large and occupying almost all the length of the apical segment, uniradiate, longitudinal, pyriform. Over this segment occur rather long dense hairs.

11. Cassida murraea L. – Bog Pleabane Shield Beetle (Fig. 22)

Coloration: body green with chalky white granules, densely aggregated dorsally and gradually diminishing in quantity on the ventral surface, where they extend as far back as the 5th segment. Median dorsal line and lateral stripes dark grey. Lateral processes and caudal filaments translucent, greenish; spiracles white. Head grey with black in the genal region; clypeus and labrum also black. Body elliptical, moderately elongate, with a blunter rounded cephalic end and the maximum width in the region of the metathorax. Length up to 7.4-8 mm, breadth up to 3.2-3.6 mm. Pronotum broadly rounded, almost semicircular; there is a slight indentation at the apex between the internal processes which are set close together, the posterior margin is saddle-shaped. Abdominal segments 1-6 short, straight, parallel sided, each having a median transverse furrow; the 7th abdominal segment is concave posteriorly, the 8th is roughly triangular, rounded at its corners, and on each side it has 4 teeth. The apical processes of the pronotum differ markedly in length – the external processes are almost twice as long as the internal; often they are bent slightly outward. The rest of the processes are long, straight, awl-shaped and directed outward at right angles to the body. Those of the thorax are longer than the middle abdominal processes. The hinder abdominal processes (those of segments 6-8) are directed posteriorly and are more elongate. Caudal filaments close together at the base, slender, straight almost twice the length of the hindermost process. Head (Fig. 23A) with an angular genal region, and with a broad elongate groove from which the 2 frontal sutures originate. Frons straight, wrinkled and clearly separated from the clypeus; this latter structure is narrow and short, somewhat curved anteriorly. Labrum very small with a convex plate anteriorly, bearing 3 toothlets. Antennae and ocelli normal. Limbs (Fig. 23B) with broad femora shaped like an axe-head. Anal appendage (Fig. 23C) situated in a slight curved identation. Its basal segment long, truncate-conical, as is the terminal segment; this latter has a toothed margin and a rounded anal boss.

12. Hypocassida subferruginea Schrank – Red Bindweed Shield Beetle (Fig. 24)

Coloration: body yellowish green. Lateral processes a delicate rosy brown, with transparent spinules. Eighth abdominal segment greyish green, caudal filaments brownish. There is an annular figure demarcated by black granules on each side of the pronotum; in addition similar granules occur irregularly on both mesothoracic and metathoracic tergites. Head grey-green with a black pattern; this consists of longitudinal strips – 1 median, the other 2 on either side of the median stripe, a dark patch on the vertex; clypeus and labrum brownish, ocelli

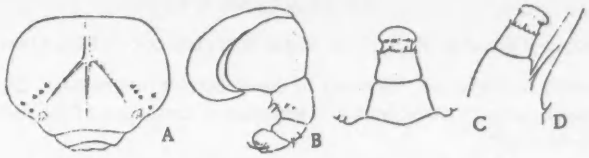

Fig. 23. Cassida murraea L. Larva: A) head; B) limb; C) anal appendage, dorsal view ; D) same, lateral view.

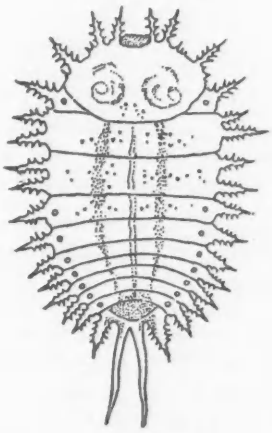

Fig. 24. Hypocassida subferruginea Schrank. General view of larva.

Fig. 25. Hypocassida subferruginea Schrank. Larva: A) head; B) limb; C) anal appendage.

black, spiracles white. Body abbreviate-oval, the greatest width is in the region of the mesothorax and metathorax. Length up to 5.7-6.0 mm, breadth up to 2.8-3.0 mm, processes up to 0.6-0.9 mm, caudal filaments up to 2.0 mm. Pronotum oval, evenly curved, slightly concave between inner apical processes, posterior margin straight. Mesothorax and metathorax broad, straight, parallel sided. Abdominal segments: first 2 broad, 3-7 much narrower, 8th broadly triangular. Lateral processes approximately equal in length, awl-shaped, straight, set at right angles to body and bearing numerous spinules of equal length. Spinules of second pair of pronotal processes extend on to sides of prothorax. Caudal filaments close together at the base, slender, straight. Body covered with light colored, short spinules. Head (Fig. 25A) without median furrow, but with 2 separate frontal sutures. Antennae normal. Six pairs of ocelli; 3 along the frontal sutures, 2 near the antennae and 1 at the side of each gena. There is a slightly concave fold at the apex of the frons; clypeus narrow, small with straight anterior edge; labrum deep, triangular with rounded comers, anterior edge faintly indented. There are a few setules along the frontal sutures and on the face of the frons. Femur (Fig. 25B) with a short annular base and sharply indented distal portion. Anal appendage (Fig. 25C) situated on the angular and sharply indented apex of the anal segment. Its basal joint is short truncate-conical; the terminal segment is also truncate-conical with a spherical apex, on which is situated an elongate, uniradiate anal aperture.

SUMMARY

The subfamily Cassidinae is morphologically and biologically a uniform group living on the herbaceous plants of the families Compositae, Convolvulaceae. They are highly specialized and ecologically conservative.

Cassidinae have been studied in water-collecting basins of the Seim, Don and Donets rivers. 20 species of this subfamily have been discovered, of which 12 are common, the others are rare ones. Larvae have been received from the following 12 species: Cassida prasina Ill., C. stigmatica Suffr., C. rubiginosa Müll., C. vibex L., C. sanguinosa Suffr., C. denticollis Suffr., C. nebulosa L., C. lineola Creutz., C. nobilis L., C. viridis L., C. murraea L., Hypocassida subferruginea Schrank.

Larvae live openly on the leaves of host-plants, sometimes on the herbaceous stems. They skeletonize the plants. The anal segment is turned up to the dorsum where the excrement protecting the insect is thrown. The majority of larvae molts twice. The larvae of the species are mesophilous, C. viridis, C. sanguinosa, C. murraea more hygrophilous, C. lineola, C. vibex more xerophilous.

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INJURIOUS FOREST COLEOPTERA OF THE GOR'KII REGION

L. K. Ésterberg

A study of the insect pests to be found in the Gor'kii Region, which was commenced in 1929, has yielded a large amount of material collected by research workers studying plant protection science, graduate students of Gor'kii State University, and others.

First place in the systematic study of this collected material was given to those families of beetles, which included among their members important pests of agricultural crops (e.g., elaterids, tenebrionids), pests of timber production (e.g., elaterids, buprestids, cerambycids and ipids), together with such forest insects as the Bostrychidae and the Lyctidae. Our early investigations into the specific composition of the soil insect fauna revealed a complete lack of previous studies on wireworms and tenebrionid larvae which damage field and garden crops and on pests of timber plantations and forestry nurseries; moreover, comparison of results from different agricultural zones within the Gor'kii Region revealed significant differences between their constituent faunas of insect pests (Ésterberg, 1935a, 1935b).

In order that the important task of protecting the forests and timber plantations of the Gor'kii Region from the ravages of insect pests may be carried out, it is first necessary to know what pests are to be found there, particularly what ipid, cerambycid and other xylophagous beetles occur. These important groups of beetles, which are so injurious to growing timber, have so far received little study (this applies particularly to the Ipidae); the species involved are incompletely and incorrectly known, and hence it has proved impossible to determine the habitats of many of them.

In the present paper, after a critical survey of the data in the literature relating to the distribution of insects in the Gor'kii Region, the author gives a series of lists of injurious forest Coleoptera from that area; these lists correct previous errors in the literature and thanks to the intensive study which has been made on the groups in question are in many cases complete.

The identification of the material which constitutes the basis of this paper, has been carried out by the author himself. As a source of comparison he has used his own personal collection of beetles, which have been identified by specialists at the Zoological Institute, Academy of Sciences, USSR, together with the collection in the Gor'kii State University, classified by N. N. Plavil'shchikov. Species, of which the author has had any doubts as to their identity, or those not represented in his own collection have been referred to the Zoological Institute, Academy of Sciences, USSR.

Very considerable help in identification of species has been given by the following specialists at the Zoological Institute – F. K. Luk'yanovich, D. A. Oglobin and A. N. Reikhardt; the majority of the cerambycids have been identified by N. N. Plavil'shchikov of the Zoological Museum, Moscow University.

From the data listed later in the article it is possible to draw certain generalizations of importance to forestry and timber production.

In the southern territories of the region where black-earth (chernozem) soils occur, the principal destructive insects of tree root-systems are species of wireworms (elaterid beetle larvae), e.g., Selatosomus aeneus L. In western territories Agriotes spp. and Selatosomus aeneus L. are the main pests, while in the northern territories of the region the same species occur together with Athous subfuscus Müll.

The destruction of these larvae in nurseries may be carried out by introducing into the soil 12% hexachlorane dust at the rate of 85 kg per hectare at a depth of not less than 10-15 cm, as a presowing treatment.

Among those groups of insects attacking felled timber of timber which has already been weakened as a result of disease or other agency, mention may be made of the following.

On pine and spruce – the great pine elaterid beetle, elaterids of the genus Ancylocheira, the blue elaterid, the fire elaterid (Melanophila acuminata Dg.), long-horn beetles of the genus Monochamus, the brilliant spruce long horn (Tetropium castaneum L.), the black costate long horn (Asemum striatum L.), the brown pine long horn (Criocephalus rusticus L.), the variegated spruce long-horn (Semanotus undatus L.), the great long horn (Acanthocinus aedilis L.), the greater and lesser pine bark beetles, bark beetles of the genus Polygraphus shot beetles, six-toothed bark beetle, typographic bark beetle, crested bark beetle, brushwood bark beetle.

On birch – the elaterid, Dicerca acuminata Pall., the variegated aspen long-horn (Rhagium mordax Dg.) and bark beetles (birch bark beetle, oak bark beetle, etc).

On oak – elaterids of the genus Chrysobothris, the twin-spot elaterid, the variable red-bodied long horn (Phymatodes testaceus L.), long horns of the genus Plagionotus and oak bark beetles.

Control measures against these secondary invaders of timber consist of such practices as the picking out of freshly infested wood up to May 15, followed by its felling not later than June 1st; the exact observance of all the rules of forestry hygiene, together with the rapid clearing up of all timber damaged or destroyed by natural agencies(e.g., fire, change in the level of the water tables, etc).

The principal cause of the multiplication of secondary invaders of timber under the conditions prevailing in the Gor'kii Region are as follows: The presence in the northern territories of large numbers of trees blown down by the wind and victims of forest fires, which are in inaccessible places remote from tracks and rivers down which logs are floated; the presence of litter and timber damaged by lumberjacks; the failure to strip off old bark from the trees during the summer months and the failure to fell freshly infested timber.

Family Elateridae – Click Beetles

There are 5 works dealing with the systematics of the elaterids and describing species of click beetles in the Gor'kii Region (Lindeman, 1871; Yakobson, 1905-1913; Ésterberg, 1935a, 1935b, 1936). In all, 51 species of click bettles have been described from this region.

1. *Adelocera conspersa* Gyll.
2. *A. fasciata* L.
3. *Brachylacon murinus* L.
4. *Corymbites pectinicornis* L.
5. *C. sjaelandicus* Müll.
6. *C. castaneus* L.
7. *Selatosomus aeneus* L.
8. *S. impressus* F.
9. *S. melancholicus* F.
10. *S. nigricornis* Panz.
11. *S. cruciatus* L.
12. *S. latus* F.
13. *S. incanus* Gyll.
14. *Prosternon tesselatum* L.
15. *Orithales serraticornis* P'k.
16. *Ludius ferrugineus* L.
17. *Agriotes aterrimus* L.
18. *A. sputator* L.
19. *A. lineatus* L.
20. *A. obscurus* L.
21. *Sericus brunneus* L.
22. *Dalopius marginatus* L.
23. *Synaptus filiformis* F.
24. *Adrastus nitidulus* Marsh.
25. *Elater sanguineus* L.
26. *E. cinnabarinus* Eschsch.
27. *E. praeustus* F.
28. *E. pomonae* Steph.
29. *E. sanguinolentus* Schrank.
30. *E. pomorum* Hbst.
31. *E. balteatus* L.
32. *E. nigroflavus* Gz.
33. *E. nigrinus* Pk.
34. *Hypnoidus riparius* F.
35. *Cryptohypnus pulchellus* L.
36. *C. quadripustulatus* F.
37. *C. tenuicornis* Germ.
38. *Melanotus rufipes* Hbst.
—. *Limonius pilosus* Leske
39. *L. aeruginosus* Ol.
40. *L. minutus* L.
41. *Athous hirtus* Hbst.
42. *A. niger* L.
43. *A. vittatus* F.
44. *A. haemorrhoidalis* F.
45. *A. subfuscus* Müll.
46. *Cardiophorus ruficollis* L.
47. *C. ebeninus* Germ.
48. *C. asellus* Er.
49. *C. equiseti* Hbst.
50. *Denticollis linearis* L.

All these species with the single exception of Limonius pilosus Leske are to be found in the author's collection; this exceptional species was described by Yakobson (1905-1913) as being widely distributed in the USSR, but this the author has been unable to confirm. For this reason Limonius pilosus Leske has been deliberately excluded from the number of species present in the region.

As a supplement to the main list we would add the following 11 species which have been found in various parts of the region:

51. Adelocera lepidoptera Pz. – found at Pil'na, June 29th, 1935 (Ésterberg), 1 example on an oak tree felled the previous year.

52. Corymbites cupreus F. subsp. aeruginosus F. – found at Pil'na, June 21, 1936 (Ésterberg), 1 example collected from an Umbellifer on the edge of an oak wood.

53. Selatosomus affinis Pk. – one example of this species discovered in a collection made in July by A. T. Vorontsova in the Vetluzhskii District (no more exact date provided).

54. S. costalis Pk. – Shar'inskii District, July 12, 1929 (G.G.U. expedition)* 1 example.

55. Agriotis ustulatus Schall. – from the Zhdano-Pil'nenskii District from July 12th to July 22, 1935 (Ésterberg); also July 15, 1936 (Ésterberg), 4 examples confined to yarrow (Achillea millefolium) flowers, growing on the northern slopes of the ravine through which flows the river P'yan. The author discovered the larva of this species in 1935 among several other species of wireworms, attacking cabbage.

56. Elater erythrogonus Müll. – Kumovsk-Vyksunskii District, July 18, 1937 (L'vov). A single example from a fallen, rotten trunk of spruce.

57. E. tristis L. – Vetluzhskii District, June 19, 1929 (G.G.U. expedition) 1 example.

58. Melanotus punctolineatus Peler. – found at Pil'na June 4, 1936 (Ésterberg) 1 example, found during the mowing of a grass plot.

59. Limonius parvulus Pz. – found at Pil'na. June 12, 1935 (Ésterberg). 1 example. Collected during the cutting down of Umbelliferae in a wood-plot. An extraordinary place in which to find this beetle.

60. Harminius undulatus Dg. – found near to Vetlug, June 22, 1929 (G.G.U. expedition) 1 example. At the Biological Field Station of the Gor'kii State University, Serezha Cherukhinsk. June 21, 1938 (Ésterberg) 1 example from a stack of spruce logs.

61. Cardiophorus erichsoni Buyss. – found at Pil'na, June 7, 1936 (Ésterberg) 1 example, on the edge of a birch wood.

The following are also of interest for the faunistic record: Selatsomus melancholicus F. (Vetluzhskii district, July 13th 1929, G. G. U. expedition. 2 examples from a spruce forest); Cardiophorus eseninus Grm. (from Pil'na May 28th 1935, Ésterberg, 1 example).

This list of click bettles found in the Gor'kii Region is by no means absolutely exhaustive; for example in the northern part of the region, typical representatives of the elaterid fauna of the taiga occur, e.g., Denticollis borealis Pk., while in the southern steppe districts it is possible to find Melanotus brunnipes Grm., Pheletes aeneoniger Deg., Athous mutilatus Rosenh., Cardiophorus nigerrimus Er. and certain others.

Family Buprestidae – Metallic Wood Borers

There are 5 monographs dealing with the Buprestid fauna of the Gor'kii Region (Yakobson, 1905-1913; Zhikharev, 1917; Vitomskii, 1928b; Ésterberg 1935a, 1930). In the territory which we have studied 28 species occur. All these species, except Phaenops guttulata Gebl. (of which there is no doubt as to the validity of its occurrence) are to be found either in the author's collection or that of the University:

1. *Buprestis mariana* L.
2. *Dicerca aenea* L.
3. *D. alni* Fisch.
4. *D. acuminata* Pall.
5. *Poecilonota variolosa* Pk.
6. *Lampra decipiens* Mnnh.
7. *Ancylocheira rustica* L.
8. *A. haemorrhoidalis* Hbst.
9. *A. novemmaculata* L.
10. *A. octoguttata* L.
11. *Phaenops cyanea* F.
12. *Ph. guttulata* Gebl. (*fulvoguttata* Harris).
13. *Melonophila acuminata* Dg.
14. *Anthaxia nitidula* L.
15. *A. quadripunctata* L.
16. *Chrysobothris chrysostigma* L.
17. *Ch. affinis* F.
18. *Coroebus sinuatus* Creutz.
19. *Agrilus biguttatus* F.
20. *A. subauratus* Gebl.
21. *A. coeruleus* Rossi.
22. *A. angustulus* Ill.
23. *A. elongatus* Hbst.
24. *A. sinuatus* Ol.
25. *A. mendax* Mnnh.
26. *A. roberti* Chvr.
27. *A. viridis* L.
28. *Trachys minuta* L.

*Gor'kii State University expedition.– Publisher.

To the above list must be added the following species:

29. Argante moesta F. found at Seima, June 22, 1933 (Ésterberg), 1 example from a felled pine tree; Eltminsk-Pervomaiskii District, August 12, 1937 (Brilev), 1 example from pine wood.

30. Agrilus betuleti Ratz. – found at Seima, June 27, 1933 (Ésterberg). 2 examples caught on the wing over a timber plot.

31. Trachys pumila Tll. – found at Pil'na, June 20, 1935 (Ésterberg), 1 example on a birch sapling.

32. Habroloma nan Hbst. – Dal'ne-Konstantinovskii District, May 27, 1934 (Ésterberg) 1 example from a flooded meadow near to Starosel'; also June 5, 1935 (Ésterberg), 1 example.

It is necessary also to note the following findings:

Agrilus roberti Chvr. – in the neighborhood of the city of Gor'kii, June 11, 1917 (Pokrovskii), 3 examples from a felled birch tree.

Ancylocheira novemmaculata L. – Lyskovo, June 17, 1929 (Malinovskii), 1 example; Vetluzhskii District July 12, 1929 (G.G.U. expedition) 1 example; G.G.U. Biological Station, Serezha Chernukhinskii District, July 2, 1937 (Ésterberg) 1 example; Vyksunskii District July 16, 1939 (Kotomin), 1 example on a felled pine trees; Shamanikha Krasno-Bakovskii District, August 18, 1937 (Ludin), 1 example from a timber yard.

Chrysobothris affinis F. – from Pil'na June 10, 1936 (Ésterberg), 1 example taken in flight over oak logs.

This list of buprestids from the Gor'kii Region is evidently almost an exhaustive list.

In the southern districts of the region Agrilus hyperici Creutz. is found on Hypericum.

Family Bostrychidae

The bostrychid fauna of the region has not yet been studied completely. All the representatives of the family mentioned here have been recorded from Gor'kii Region for the first time.

1. Stephanopachys linearis Kug. – from the neighborhood of the city of Gor'kii, August 14, 1931 (Ésterberg), 2 examples found in the bark of a pine tree stump, attacked by ipids; Kumovsk-Voznesenskii district, August 25, 1937 (Khitrovskii), 15 examples in the bark of a felled spruce tree; Serezha, Chernyukhinskii District, Gor'kii State University Biological Station, April 9, 1938 (Ésterberg), 3 examples under the bark of a stout pine stump; Shamanikha, Krasno-Bakovskii Region, August 18, 1937 (Ludin), 2 examples in the bark of a spruce; near to Krasnye-Baki, August 20, 1937 (Ludin), 3 examples in spruce bark.

2. S. substriatus Pk. – Vetluzhskii District, July 14, 1929 (G.G.U. expedition), 1 example under spruce bark attacked by ipids.

3. Bostrychus capucinus L. – found at Pil'na, from May 27th to June 22, 1937 (Ésterberg), 71 examples on new oak stumps, and on brushwood and logs around felled oaks. Mass appearance from the end of May to the beginning of June.

4. Xylonites retusus Ol. – Zhdanova, Pil'nenski Region, June 14, 1935 (Ésterberg), 1 example, a male, on a withered spruce in a park, Pil'na, June 10, 1936 (Ésterberg), 1 example, a female, on a felled oak in an oak/birch plantation.

This list of bostrychid species from the Gor'kii Region would appear to be complete.

Family Lyctidae – Powder-Post Beetles

Yakobson (1905-1913) described Lyctus pubescens Pz. as a species widely distributed in Central Russia, without specifically mentioning its occurrence in the Lower Gorodskii Province. The author has collected 2 species belonging to this family, and these appear to be the only representatives present in the Gor'kii Region.

1. Lyctus pubescens Panz. – from Pil'na, May 27, 1936 (Ésterberg).

2. Lyctus linearis Goeze – from Pil'na, June 10, 1936 (Ésterberg), 19 examples from the same oak tree and under similar conditions to the previous species.

Family Tenebrionidae – Darkling Beetles

There are 5 works dealing with the tenebrionid beetle fauna of the Gor'kii District (Lindeman, 1871; Semenov, 1898; Ésterberg, 1935a; Reikhardt, 1936; Ésterberg, 1936). Only 10 species are quoted in these works as belonging to the district. It would appear that this family has previously been neglected as a constituent of the beetle fauna of the area. Hence, a considerable number of species are recorded here for the first time from the area:

1. *Blaps halophila* Fisch.
2. *Platyscelis hypolithos* Pall.
3. *Pedinus femoralis* L.
4. *Melanimon tibiale* F.
5. *Opatrum sabulosum* L.
6. *Tribolium confusum* Duv.
7. *Uloma perroudi* Mls.
8. *Upis ceramboides* L.
9. *Tenebrio obscurus* F.
10. *T. molitor* L.

All these species except Platyscelis hypolithos Pall. (of which there is no doubt as to the regular occurrence) are to be found in the author's collection, or in the collection of the Gor'kii University.

To this list must be added the following:-

11. Blaps mortisaga L. – Gor'kii, June 17, 1930, a single specimen was obtained from the banks of the River Oka.

12. B. lethifera Mrsh. – from Zhdanov, Pil'nenskii Region, August 27, 1936 (Ésterberg). The remains of female belonging to this species was found in soil dug out from an excavation [soil – degraded black-earth (chernozem)].

13. Opatrum riparium Gerh. – found at Pil'na May 27, 1936 (Ésterberg), 1 example on the banks of the River P'yan in a sandy plot. In the author's collection there are examples of this species taken in the Udmurt Autonomous Republic and the Kirov Region: near the town of Izhevsk, July 29, 1931 (Nikitina), 1 example; from Kil'mez in the Kil'mezskii District of Kirov, July 16, 1932 (Petrestoronin), 1 example. The distribution of this species within the USSR has received little study.

14. Crypticus quisquilius L. – found at Dzherzhinsk, June 15, 1906 (Malinovskii), 1 example from sandy soil in a pine forest; Lyskovo, June 20, 1921 (Malinovskii), 1 example; Pil'na, June 21, 1935 (Ésterberg), 4 examples in sandy soil at the base of pine trees. This species, like the following, is generally found in the southern forest zone.

15. Boletophagous reticulatus L. – Lyskovo, September 13, 1929 (Malinovskii), 5 examples found in a fungus, Boletus, growing on birch trees; from Staraya Pustyn', Cherukhinskii District, June 14, 1936 (Braginskaya), 2 examples from the fungus Boletus on a rotten birch trunk.

16. Eledona agaricola Hbst. – from Staraya Pustyn', Cherukhinskii District, July 12, 1936 (Braginskaya), 1 example.

17. Scaphidema metallica F. – found Pil'na, June 24, 1935 (Ésterberg), 2 examples from an oak/birch wood felling.

18. Diaperis boleti L. – from the neighborhood of Gor'kii, June 14, 1905 (Ozerov), 3 examples; Dzherzhinsk town, July 2, 1905 (Shcherbakov), 4 examples; Kulebakskii District, June 20, 1912 (Ul'yanov), 1 example; Pil'na, June 19, 1936 (Ésterberg), 1 example from under the bark of a rotting birch stump.

19. Hoplocephala haemmorrhoidalis F. – from Staraya Pustyn', Chernukhinskii District, June 14, 1936 (Braginskaya), 2 examples from Polyporus fungi on rotting birch wood, together with Boletophagus reticulatus L.

20. Hypophloeus longulus Gyll. – from Zhdanovo, Pil'nenskii District, May 20, 1935 (Ésterberg), 1 example from a tunnel in an elm stump made by an ipid beetle.

21. H. fraxini Kug. – from Pil'na, June 17, 1936 (Ésterberg), 2 examples from ipid tunnels in elm logs, conveyed there to repair a school.

22. H. pini Fz. – Dal'ne-Konstantinovskii District, July 11, 1934 (Ésterberg), 28 examples found in tunnels made by ipids in a pine tree blown down by the wind.

23. H. suturalis Pk. – Dal'ne-Konstantinovskii District, July 18, 1934 (Ésterberg), 1 example found alongside the previous species.

24. H. bicolor Ol. – the neighborhood of Gor'kii, June 13, 1905 (Pokrovskii), 1 example; in the same place May 22, 1931 (Ésterberg), 1 example under the bark of a pine tree; from Zhdanovo, Pil'enskii district from May 12th-22nd, 1935 (Ésterberg), 9 examples from ipid tunnels in an elm stump; Pil'na, August 2, 1935 (Ésterberg), 1 example in the timber of an old shack, also in Pil'na May 21, 1936 (Ésterberg), 1 example from an oak log, attacked by bark beetles.

25. H. linearis F. – Balakhninskii District, June 9, 1905 (Pokrovskii), 1 example; Kstovskii District, August 16, 1911 (Malinovskii), 2 examples in ipid tunnels in pine.

26. Tribolium madens Chrp. – found city of Gor'kii, August 18, 1931 (Ésterberg), 1 example in a room; same place May 16, 1932 (Ésterberg), 1 example; Pil'na May 20, 1935 (Ésterberg), 3 examples from a peasant's hut; from Zhdanovo, Pil'nenskii District, June 2, 1936 (Ésterberg), 11 examples in wasps' nests and the nests of bumblebees, found on the walls of an old shack; the beetles appeared to be inquilines in the nests.

27. T. castaneum Hbst. – from city of Gor'kii, July 25, 1930 (Ésterberg), 2 examples in a sample of meal which was infested with insects of various kinds; here also were large numbers of T. confusum Duv.

28. Gnathocerus cornutus F. – from city of Gor'kii, August 17, 1930 (Ésterberg), specimens of this species were discovered by the author, destroying grain and meal in warehouses on the Siberian wharf on the banks of the River Volga.

29. Tenebrio picipes Hbst. – Dal'ne- Konstantinovskii District September 3, 1905 (Malinovskii), 1 example; Seima, August 12, 1907, (Malinovskii), 1 example in a room.

30. Bius thoracicus F. – found Seima, May 10, 1907 (Malinovskii), 1 example; from Zhdanovo, Pil'nenskii Districts May 10, 1936 (Ésterberg), 2 examples from the bark of a fir tree which had fallen down and was lying in a desiccated condition in a park; 2 larvae of the same species were found.

31. Boros schneideri Pz. – Shar'inskii District, July 12, 1929 (G.G.U. expedition), 1 example; Vyksunskii District, July 16, 1937 (Kotomin), 1 example found under the bark of a charred pine tree; Pristansk, Vyksunskii District, July 21, 1937 (Kalinina), 2 examples from beneath the bark of a pine log; in the neighborhood of Lukoyanov town, August 11, 1937 (Fedoseev), 1 example; Urenskii District, July 11, 1938 (Pisarev), 1 example, found under the bark of a felled pine tree, infested with cerambycids and ipids.

The finding of Upis ceramboides L. deserves mention; this species was found July 6, 1905 by Malinovskii, 1 example, under the bark of a desiccated birch log; also March 2, 1908 by Uskova, 1 example from the neighborhood of city of Gor'kii; Vasil'surskii District, August 13, 1911, by Ul'yanov, 1 example from a rotten birch tree.

This list of the tenebrionid fauna of the Gor'kii Region is almost exhaustive. In southern parts of the region Platydema dejeani Lap., Helops caraboides Pz. and a few others may be expected to occur.

Family Cerambycidae – Long Horn Beetles

There are 6 works which deal with the cerambycid fauna of the region under survey (Lindeman, 1871; Semenov, 1899; Plavil'shchikov, 1917; Vorontsov, 1926; Ésterberg, 1935a, 1936). For the territory under survey, these works list a total of 84 species of long horns, 2 of which appear completely incredible as members of the fauna of Nizhegorodskii Province. Lindeman (1871) for example cites Haplocnemia nebulosa F. – this should probably be H. (= Mesosa) myops Dalm., and Vorontsov (1926) notes the presence of Monochamus sartor F. as a serious destroyer of pine; he is evidently confusing the latter species with M. sutor L. or M. urussovi Fish.-W., both of which are far more likely to be present. All the rest of the species, apart from Oedecnema dubia F. (of which there is not doubt as to the validity of the record) are to be found in the author's collection or the University collection.

1. *Prionus coriarius* L.
2. *Rhagium sycophanta* Schrnk.
3. *Rh. mordax* Deg.
4. *Rh. inquisitor* L.
5. *Rhamnusium bicolor* Schrnk.
6. *Toxotus cursor* L.
7. *Stenocorus meridianus* L.
8. *Pachyta quadrimaculata* L.
9. *Evodinus interrogationis* L.
10. *Gaurotes virginea* L.

11. *Acmaeops marginata* F.
12. *A. pratensis* Laich.
13. *A. collaris* L.
14. *Cortodera femorata* F.
15. *Allosterna tabacicolor* Deg.
16. *Leptura livida pecta* Dan.
17. *L. maculicornis* Deg.
18. *L. rubra* L.
19. *L. variicornis* Dalm.
20. *L. sanguinolenta* L.
21. *L. dubia* Scop.
22. *L. virens* L.
23. *Judolia cerambyciformis* Schrnk.
24. *Oedecnema dubia* F.
25. *Strangalia nigripes* Deg.
26. *S. thoracica* Creutz.
27. *S. quadrifasciata* L.
28. *S. arcuata* Pz.
29. *S. aethiops* Poda.
30. *S. melanura* L.
31. *S. bifasciata* Müll.
32. *S. pubescens* F.
33. *Strangalina attenuata* L.
34. *Necydalis major* L.
35. *Molorchus minor* L.
36. *Obrium cantharinum* L.
37. *Dilus fugax* Ol.
38. *Aromia moschata* L.
39. *Purpuricenus kaehleri* L.
40. *Rhopalopus macropus* Germ.
41. *Semanotus undatus* L.
42. *Phymatodes testaceus* L.
43. *Callidium aeneum* Deg.
44. *C. coriaceum* Pk.
45. *C. violaceum* L.
46. *Spondylis buprestoides* L.
47. *Tetropium castaneum* L.
48. *T. fuscum* F.
49. *Asemum striatum* L.
50. *Criocephalus rusticus* L.
51. *C. ferus* Muls.
52. *Xylotrechus rusticus* L.
53. *Clytus arietis* L.
54. *Chlorophorus herbsti* Brahm.
55. *Plagionotus detritus* L.
56. *P. arcuatus* L.
57. *Monochamus urussovi* Fisch.-W.
58. *M. sutor* L.
59. *M. galloprovincialis pistor* Germ.
—. *M. sartor* F.
60. *Lamia textor* L.
61. *Acanthoderes clavipes* Schrnk.
62. *Acanthocinus aedilis* L.
63. *A. griseus* F.
64. *Exocentrus lusitanicus* L.
65. *Pogonochaerus fasciculatus* Deg.
66. *P. ovatus* Gz.
67. *Mesosa myops* Dalm.
—. *M. nebulosa* Oliv.
68. *Anaesthetis testacea* F.
69. *Saperda carcharias* L.
70. *S. populnea* L.
71. *S. scalaris* L.
72. *S. perforata* Pall.
73. *Menesia bipunctata* Zoubk.
74. *Agapanthia villosoviridescens* Deg.
75. *A. violacea* F.
76. *Tetrops praeusta* L.
77. *Phytoecia cylindrica* L.
78. *Ph. nigricornis* F.
79. *Ph. icterica* Schall.
80. *Oberea pupillata* Gyll.
81. *O. oculata* L.
82. *O. erythrocephala* F.

The following are new records for the fauna of the region:

83. Tragosoma depsarium L. — found in Gork'ii, attracted to light in the evening, June 27, 1936 (Blokhin), 1 example; Vyksunskii District, August 20, 1937 (Kotomin), 1 example on a felled pine tree.

84. Pachyta lamed L. — Shar'inskii District, June 28, 1929 (G.G.U. expedition), 1 example.

85. Nivellia sanguinisa Gyll. — Shar'inskii District, June 28, 1929 (G.G.U. expedition), 1 example on an umbelliferan inflorescence. A typical "taiga" species.

86. Judolia sexmaculata L. var. tatrica Cep. — Dal'ne-Konstantinovskii District, June 15, 1934 (Ésterberg), 1 example on an umbelliferan inflorescence, on the edge of a birch forest; var. trifasciata F. — Staraya Pustyn', Chernukhinskii District, July 7, 1937 (Ésterberg), 1 example from a margeurite (Chrysanthemum leucanthemum) flower; also in the same place June 17, 1937 (Ésterberg), 1 example from a buttercup (Ranunculus) flower; var. tyrolense Rtt. — Kavkazsk Pervomaiskii District, August 27, 1937 (Brilev), 1 example from an umbelliferan inflorescence; f. typica — Staraya Pustyn', Chernukhinskii District, June 8, 1937 (L'vov), 1 example; from the same place, June 8, 1938 (L'vov), 1 example.

87. Judolia erratica Dalm. var. anticedivisa Pic. — from the neighborhood of Gor'kii, Mokhovii Hills, May 22, 1930 (Ésterberg), 1 example.

88. Strangalia maculata Poda. — from Vereya Vyksunskii District, July 14, 1937 (L'vov), 2 examples; Panzelka settlement, Lukoyanskii District, July 28, 1937 (L'vov), 2 examples from composite and umbelliferan inflorescences. This is an extremely interesting habitat for this species; var. binotata Mls. — from Vereya, Vyksunskii District, July 14, 1937 (L'vov), 1 example from a composite inflorescence.

89. S. nigra L. — Pochinkovskii District, July 5, 1932 (Barabanova), 1 example collected from a flowering plant growing among bushes.

90. Molorchus kiessenwetteri Muls. – from Pil'na, July 1, 1935 (Ésterberg), 3 examples collected from a bush growing on the bank of the R. P'yana. A very interesting but most unexpected find among the fauna of the region.

91. Rhopalopus clavipes F. – Pochinkovskii District, June 22, 1932 (Barabanova), 1 example.

92. Phymatodes alni L. – Lyskovo, May 25, 1922 (Malinovskii), 1 example; from Zhdanov, Pil'nenskii District, June 3 to June 8, 1935 (Ésterberg), 53 examples on fresh alder catkins near to cabbage plants in a collective market garden, collected from the bracts and sex organs; a mass flight June 4.

93. Nothorrhina punctata F. = (muricata Dalm.) – from Pil'na, July 3, 1935 (Ésterberg), 1 example collected from an oak/birch plantation.

94. Xylotrechus antilope Ztt. – from Pil'na, June 14, 1936 (Levashova), 1 example on an oak log in an oak plantation. An extraordinarily interesting site.

95. Cyrotoclytus capra Grm. – Shar'inskii District, July 10, 1929 (G.G.U. expedition), 1 example.

96. Acanthocinus carinulatus Gebl. – from city of Gor'kii, January 16, 1937 (Ésterberg), 1 dead example in a fir log among firewood obtained from the Semenovskii District.

97. Leiopus punctulatus Pk. – from Seima, June 23, 1933 (Ésterberg), 1 example; Kumovsk Vyksunskii District, July 17, 1937 (L'vov), 2 examples from a stack of larch billets.

98. L. nebulosus L. – from the neighborhood of city of Gor'kii, July 18, 1929 (Ésterberg), 1 example collected in a park.

99. Hoplosia fennica Pk. – from Pil'na, June 10, 1936 (Ésterberg), 1 example found in an oak log in an oak plantation; from Serezha Biological Station of Gor'kii State University, Chernukhinskii District, June 15, 1937 (L'vov), 1 example.

100. Phytoecia pustulata Schrnk. – from Uzhovka, June 3, 1931 (Meshalova), 1 example collected in a flooded meadow.

The following faunistic records are also of interest:

Rhamnusium bicolor Schrnk. var. symmetricum Kanabé – Vorisovo-Pokrovskoe, Dal'ne-Konstantinovskii District, June 23, 1932 (Blokhin), 1 example captured in flight.

Toxotus cursor L. – from Seima, July 13, 1933 (Esterberg), 1 example; Chernukhinskii District, May 28, 1936 (Braginskaya), 2 examples from a pine forest. Cortodera femorata L. – from Staraya Pustyn', Chernukhinskii District, June 8-10, 1937 (L'vov, Neruchev, Popova, Ésterberg), 11 examples collected on the edge of a pine forest interspersed with solitary oak trees; the specimens were captured on mountain ash growing by the side of a stream which fed Lake Svyat; var. suturifera Rtt. – in the same place, from June 4-10, 1937 (L'vov, Popova, Ésterberg), 28 examples together with specimens of the type. Leptura variicornis Dalm. – from Obrochnoe, June 25, 1927 (Vorontsov), 6 examples.

Judolia cerambyciformis Schrnk. – found Novink landing stage on the R. Oka, July 15, 1930 (Kiseleva), 1 example from an umbelliferan inflorescence in an orchard; var. sexpunctata Mls. – same place, July 20, 1937 (Malinovskii), 2 examples from an Umbellifer growing on the outskits of the forest; var. bisquadristigma Pik. – from the neighborhood of Lyskova, May 30, 1922 (Malinovskii), 1 example from a globe-flower (Trollius).

Strangalia thoracica Creutz. – from Elovitsa village, Bororodskii District, June 17, 1921 (Dmitriev), 1 example; collected from forest by the River Kud'me Chernukhinskii District, May 8, 1936 (Braginskaya), 1 example found dead in decayed aspen wood; var. ussurica Pik. – from the neighborhood of Lyskova, July 4, 1933 (Malinovskii), 1 example in Neverovskii forest.

Dilus fugax Ol. – from Serezha Biological Station of Gor'kii State University, Chernukhinskii District, from May 21 to June 8, 1938 (Ésterberg), 16 examples on Cytisus flowers and on Ranunculus sp.

Purpuricenus kaehleri L. – from around Lyakoyanov, June 20, 1937 (Fedoseev), 1 example; from the same place August 4, 1937 (Ésterberg), 1 example from a young birch in an oak forest.

Semanotus undatus L. – from Uzhovka, November 12, 1921 (Dutova), 3 examples taken from a felled spruce; from Seima, June 16, 1933 (Ésterberg), 1 example; from the same place July 14, 1933 (Ésterberg), 1 example from a spruce wood; Chernukhinskii District, June 14, 1938 (Ésterberg), 1 example from a desiccated spruce.

Tetropium fuscum F. – from Gor'kii, March 7, 1932 (Ésterberg), 2 examples taken in a room from a log used as firewood, derived from the Borskii District.

Phymatodes testaceus L. – from Pil'na, June 15-22, 1936 (Ésterberg), 42 examples found in a forest and in newly felled oak trees in a clearing; the var. rufipes predominated, but there was also a single specimen of var. testaceus F. At the same time large numbers of Mesosa myops Dalm. were collected; this long horn is somewhat rare in the region.

Exocentrus lusitanicus L. – found Pil'na, July 1, 1935 (Ésterberg), 1 example from the walls of a peasant's hut.

Pogochaerus ovatus Gz. – from Seima, July 29, 1933 (Ésterberg), 2 examples on fresh pine stumps in a clearing.

Phytoecia icterica Schall. – from Pil'na, June 22, 1936 (Ésterberg), 1 example collected in meadow on the bank of the P'yan.

This list of the cerambycid fauna of the Gor'kii Region is not an exhaustive one. In the northern part of the region certain northern and Siberian forms may be found, particularly in the coniferous forests of the mountains – Evodinus borealis Gyll., Acmaeops smaragdula F., A. septentrionis Thoms., Xylotrechus ibex Gebl., X. arvicola Oliv., Monachamus salturarius Gebl., whereas in the southern steppe lands there are – Agapanthia dahli Richt., and Phytoecia affinis Pz.

It is possible to find also Grammoptera erythropus ingrica Baeckm., Leptura sexguttata F., Gracilia minuta F., Pogochaerus hispidulus Pill., Mesosa curculionoides L., Saperda similis Laich. and certain other species.

Family Ipidae – Bark Beetles

There are 10 works dealing with the ipid fauna of the region (Lindeman, 1871; Vorontsov, 1926; Vitomskii, 1928a, 1928b; Ésterberg, 1928; Spesivtsev, 1931; Ésterberg, 1935a, 1936; Stark, 1952). In these works a total of 54 ipid species are recorded for the Gor'kii Region, including 2 species, which although they are mentioned as having been found within the confines of the Nizhegorodskii Province, appear as improbable member of the fauna. Thus, Vorontsov (1926) cites Carphoborus minimus as a species occurring in the region. This record should obviously read C. cholodkovskyi Spess. – a species which occurs relatively frequently in the northern districts of the region, whereas C. minimus F. has never been found by the author either in the region itself or in the collection made by A. T. Vorontsov. The other improbable record is that of Carphoborus teplouchovi Spess noted as occurring in the Nizhegorodskii Province by Yatsentkovskii (1930: 38) without any reference to its exact locality, despite the fact that in the text Yatsentkovskii points out that this is a new (?) and thus highly interesting record. Furthermore on page 151 of his article, Yatsentkovskii mentions a species C. rossicus Sem. (as in the collection of N. F. Vitomskii from the Siberian fir) which he suggests may be found in the Gor'kii region, although he makes no further mention of it in the text, nor does he list it among the species found in the territory. It would seem probable that Carphoborus teplouchovi Spess. should be replaced by C. rossicus in his list, for the latter species has been found on many occasions by other authors.

1. *Scolytus multistriatus* Mrsh.
2. *Sc. pygmaeus* F.
3. *Sc. ratzeburgi* Jans.
4. *Sc. scolytus* F.
5. *Sc. laevis* Chap.
6. *Sc. mali* Bechst.
7. *Sc. rugulosus* Ratz.
8. *Sc. morawitzi* Sem.
9. *Sc. intricatus* Ratz.
10. *Phthorophloeus spinulosus* Rey.
11. *Hylurgus ligniperda* F.
12. *Hylurgops palliatus* Gyll.
13. *H. glabratus* Zett.
14. *Hylastes ater* Pk.
15. *H. cunicularius* Er.
16. *H. opacus* Er.
17. *Leperesinus fraxini* Pz.
18. *Xylechinus pilosus* Ratz.

19. *Dendroctonus micans* Kug.
20. *Blastophagus piniperda* L.
21. *B. minor* Hart.
22. *Polygraphus subopacus* Thoms.
23. *P. poligraphus* L.
24. *Carphoborus rossicus* Sem.
25. *C. cholodkovskyi* Spess.
—. *C. minimus* F.
—. *C. teplouchovi* Spess.
26. *Crypturgus cinereus* Hrbst.
27. *C. hispidulus* Thoms.
28. *C. pusillus* Gyll.
29. *Ernoporus tiliae* Pz.
30. *Dryocoetes baicalicus* Reitt.
31. *D. autographus* Ratz.
32. *D. hectographus* Reitt.
33. *Xyloterus domesticus* L.
34. *X. lineatus* Oliv.
35. *X. signatus* Oliv.
36. *Anisandrus dispar* F.
37. *Xyleborus cryptographus* L.
38. *Pityophthorus micrographus* L.
39. *Pityogenes chalcographus* L.
40. *P. irkutensis* Egg.*
41. *P. bidens* F.
42. *P. quadridens* Hart.
43. *Ips acuminatus* Eichh.
44. *I. sexdentatus* Boern.
45. *I. duplicatus* Sahlb.
46. *I. typographus* L.
47. *I. subelongatus* Motsch.**
48. *Neotomicus longicollis* Gyll.
49. *N. starki* Spess.
50. *N. proximus* Eichh.
51. *N. suturalis* Gyll.
52. *N. laricis* F.

Species which have not previously been recorded for the region may be listed as follows:

53. Polygraphus punctifrons Thoms. – according to N. F. Vitomskii this species was collected by him in 1928-29 from a fir tree in the Krasno-Bakovskii District.

54. Trypophloeus asperatus Gyll. – according to N. F. Vitomskii this species was collected by him in 1928-29 from a fir tree in the Krasno-Bakovskii District; Chernukhinskii District, July 21, 1937 (Ésterberg), a mass flight of this beetle took place from the bark of fallen aspen trees. Tunnels made by this species occur very frequently in aspen throughout the region.

55. Cryphalus salturarius Ws. – according to N. F. Vitomskii this species was collected by him in 1928-29 from a fir tree in the Krasno-Bakovskii District.

56. Cryphalus abietis Ws. – 3 examples of this species were discovered in A. T. Vorontsov's collection from the Vetluzhskii district, dated 1925 (more precise date is lacking).

57. Pityophthorus lichtensteini Rtz. – found Seima, June 29, 1933 (Ésterberg), 3 examples from a slender branch of a pine, withered at the roots.

58. P. morosovi Spess. – Dal'ne-Konstantinovskii District, July 19, 1934 (Ésterberg), 4 examples from a slender fir branch on a tree which was dying as a result of its roots being laid bare.

59. P. tragardhi Spess. – according to N. F. Vitomskii this species was collected by him in 1928-29 from a fir tree in the Krasno-Bakovskii District.

All these species except for T. asperatus Gyll. are widely distributed in the "taiga" zone and their occurrence in the Gor'kii Region is what one would expect.

Scolytus laevis Chap. – according to N. F. Vitomskii this species was collected by him in 1928-29 from an elm in the Krasno-Bakovskii District.

Hylurgops glabratus Zett. – Borskii District, May 16, 1930 (Ésterberg), 7 examples on the roots of a felled spruce tree.

Hylastes cunicularius Er. – according to N. F. Vitomskii this species was collected by him in 1928-29 from a pine tree in Krasno-Bakovskii District.

Leperesinus fraxini Pz. – from the Zhdanovo Pil'nenskii District, July 1, 1935 (Ésterberg), 2 examples from a park, where ash trees were very commonly attacked by beetles; also in the same place, May 29, 1936 (Ésterberg), 1 example on an ash log.

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*Shown by the author to be identical with P. monacensis Fisch. – a species which according to recent investigations by Stark (1952) is distributed throughout s. w. Ukraine, Caucasia and Central Europe. The latter author has collected together all the records relating to P. irkutensis Egg. from other parts of the USSR and shown that the species occupies the whole of the coniferous forest region of Siberia and European USSR, extending as far south as s. w. Ukraine; this species is therefore listed by us in the table.

**Listed by N. F. Vitomskii (1928b) as occurring in the Krasno-Bakovskii District, (citation followed by a question mark); this record appears highly probable for the district concerned but requires confirmation; Yatsentkovskii (1930) quotes this record, on the basis of Vitomskii, without casting any doubt on its validity.

Dendroctonus micans Kug. – according to N. F. Vitomskii this species was collected by him in 1928-29 from a pine tree in the Krasno-Bakovskii District; Chernukhinskii District, June 2, 1938 (Ésterberg), 1 example caught in flight.

Carphoborus rossicus Sem. – according to N. F. Vitomskii this species was collected by him in 1928-29 from a spruce tree growing in the Krasno-Bakovskii District.

C. cholodkovskyi Spess. – discovered in quantity by Vorontsov from the Vetluzhskii District, 1925 (further data lacking); Borskii District, May 16, 1930 (Ésterberg), 16 examples from a withered pine tree. According to Vitomskii this species was collected by him in 1928-29 from a pine tree growing in the Krasno-Bakovskii District.

Dryocoetes hectographus Reitt. – according to Vitomskii this species was collected by him from fir and spruce in 1928-29 in the Krasno-Bakovskii District.

Xyloterus domesticus L. – according to Vitomskii this species was collected by him in 1928-29 from birch in the Krasno-Bakovskii District; Gor'kii State University Biological Station, Serezha, Chernukhinskii District, June 20-22, 1938 (Ésterberg), captured in quantity on felled birch trees; oviposition was taking place in the tunnels made by the beetles, and occasional masses of eggs were found, together with numerous larvae of various ages but no pupae.

Anisandrus dispar F. – according to Vitomskii this species was collected by him in 1928-29 from a birch in the Krasno-Bakovskii District; from Pil'na, June 22, 1936 (Ésterberg), 2 females on an oak stump.

Xyleborus cryptographicus L. – according to Vitomskii this speices was collected by him from an aspen in the Krasno-Bakovskii district; from Serezha, May 10, 1938 (Ésterberg), 1 dead specimen from under the bark of an aspen stump.

Neotomicus longicollis Gyll. – from the vicinity of Gor'kii, Mokhovii Hills, May 22, 1930 (Ésterberg), 7 examples from the lower portion of an old pine-tree with withered roots; all found beneath the bark.

N. starki Spess. – according to Vitomskii this species was found by him in 1928-29, on spruce and fir growing in the Krasno-Bakovskii District; Gor'kii State University Biological Station, Serezha, Cherukhinskii District, April 8, 1938 (Ésterberg), found in quantity at the tips of slender branches of a spruce dying at the roots; for the most part the beetles had overwintered as sexually mature adults which has commenced oviposition in the autumn or (rarely) as first instar larvae in hibernaculae; the thicker branches of the same tree were infested with X. pilosus Ratz., and the trunk by P. subopacus Thoms.

This list of species comprising the ipid fauna of the Gor'kii Region is undoubtedly an incomplete one; to it must certainly be added: Trypophloeus alni Lindem., T. granulatus Ratz., Dryocoetes alni Georg., Lymantor coryli Pz., Pityophthorus glabratus Eichh. and certain others. Further studies on the ipid fauna of the Gor'kii Region should pay particular attention to investigating the alder, hazel and other deciduous trees.

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RHOPALOCERA OF THE UKHTA DISTRICT, NORTHEAST OF THE EUROPEAN PART OF THE USSR

K. F. Sedykh and E. D. Sedykh

The Ukhta Districtof the Komi ASSR is located within the taiga zone, between the 62nd and the 65th parallels and, together with the major part of the Komi ASSR, may be rightly called a land of forests, rivers and swamps. The numerous lakes in various stages of stagnation contribute still more to the variety of the landscape.

Such a variety of natural conditions, as well as the fact that the Komi ASSR is located at the meeting point of the eastern European and the western Siberian parts of the Soviet Union, is reflected in the species complex of the animal and plant kingdoms, which is enriched by a whole series of Siberian species.

The main species in the Ukhta forests are the spruce, pine, siberian larch and birch. Not as concentrated and more isolated, and not in all localities,there are forests made up of aspen, fir and cedar, (Siberian pine). In the undergrowth may be found mountain ash, bird cherry, blue honeysuckle, filipendula, wild rose, raspberry and different currants.

The most extensive in area are the spruce forests which grow in very different conditions, from inundated river valleys to the summits of watersheds. Pine groves are located on grove river terraces and in the lower parts of watersheds. The agricultural regions are not extensive and are mostly found along rivers. The same is true for pastures.

The agricultural activity of man is reflected in the composition of the animal and plant kingdoms, some species retreat to the forests and become rare, others, on the contrary, become more numerous every year. Thus, near Ukhta, as the area used for the cultivation of cruciferous plants is increased, the number of garden pierids also increases every year.

The insect fauna of the Ukhta District of the Komi ASSR until now had hardly been studied by anyone. Beginning in the spring of 1946, and for the following 11 years, the authors have conducted systematic faunistic collections and made phenological observations on the higher insects in the vicinity of Ukhta and in the Ukhta District. On the whole, the collections were made in river valleys. Thus, the river Sed'yu has been studied repeatedly along both banks for a length of about 80 km, starting from its right tributary, the stream Kerana, to its mouth. The following were also studied: the Izhma valley, from the river Sed'yu to the Lake Izhemskii, for a length of about 35 km; the Chut' valley for a length of 8-10 km from the mouth upstream; the Tobys' valley from the tributary Ukhtarka to the mouth, which makes about 80 km, and the Ukhta valley for a length of 120-125 km, from the mouth of the Tobys' to the confluence of the Ukhta and the Izhma. In the vicinity of the town, systematic excursions were undertaken within a radius of 10-15 km, and of course, different stations and biotopes were visited. As a result of these collections, the Rhopalocera were most completely collected and studied, and their list is given below.

A Phenological Account of the Biology of Rhopalocera

The spring thawing of the snow begins in the end of March or the beginning of April. The first of the Rhopalocera to appear is Vanessa urticae. The snow is all gone by the middle of April, the days are very warm, ice breaks, and coltsfoot, goat willow, violets and daphne begin to blossom. Two more nymphalids, Vanessa antiopa and Polygonia c-album, emerge from their winter hibernation, and the first proper spring butterfly, Callophrys rubi, makes its appearance.

A short cold spell returns in the month of May, very often in the very beginning of the month. After the new heat wave, tree and shrub buds burst, and "goose onion" and birthwort begin to blossom: the swamps and low-lying regions are covered by the yellow ocean of cowslips. The April butterflies, although rather tattered, are still found, but three new species begin to fly,: Euchloë cardamines, Chrysophanus amphidamas and Leptidia sinapis; to replace the absence of other species, the two latter ones are found in very great numbers.

June is a true summer month. The trees are fully covered with leaves; bird cherry, bitter vetch, wild rose, avens begin to blossom. The fields along river banks become entirely yellow due to the millions of dandelions and buttercups, while the drier places are covered by large blowballs. In the lower regions, to replace cowslips, which toward June have completed their blossoming, appear neat rows of globeflower with round yellow heads. Under the forest canopy begin to bloom the white stars of "sedmichnik" and the purple clusters of Astragalus.

Day by day there are more and more flowers. In the second and third decades of June the forest hills become blue due to the abundance of the forest geranuim, which is supplemented in the stream valleys by forget-me-nots. Among the dense, dark greenery of their bushes, peonies begin to bloom, while young trees and shrubs become ornamented by the garlands of white bells of the northern liana — the Siberian "knyazhik." In the shade of spruces orchids bloom, while in more open spaces there are the curious pink and yellow Venus' slippers. In the lakes the flowers of pond lilies open,the forest becomes filled with the aroma of bird cherry and the flowering mountain ash. Different cereal plants and clovers begin to blossom.

June is characterized also by a great number of diurnal butterflies. Euchloe cardamines, Chrysophanus amphidamus, L. sinapis and completely tattered Callophrys rubi are still there, but there is a number of other species: Papilio machaon, nymphalids: Melithea dictynna, M. athalia, M. maturna, Brenthis selene, Br. euphrosyne, Br. freja, Br. frigga, Pyrameis cardui, Pararge hiera; pierids: Pieris brassicae, P. napi; lycaenids: Lycaena eumedon, L. astrarche; hesperiids: Pamphila palaemon, P. silvius, Hesperia carthami, H. alveus, H. serratulae.

In July the plants and animals reach the maximum of their development. Flowering plants form extensive multicolored streaks and spots in open places. In river and stream valleys globeflowers are replaced by blue veronica, white Filipendula, interspersed with the yellow stars of the goldenrod, Siberian crepis, spear-leafed cacalia. Along dry places there are hundreds of chamomiles, oxeyes, toad-flax, tancies, Siberian melgidium. Great willow herb begins to blossom in the woods, wormwood along river banks, and thistles in the fields. The tallest umbelliferous plants, Siberian heracleum, also bloom.

Diurnal butterflies are still numerous; along with a few June butterflies, such as Hesperia alveus, H. serratulae, there are Argynnis ino, A. aglaja, Lycaena icarus, L. donzelii, Chrysophanus virgaureae, Ch. hippothoë, Erebia euryale.

August is a definite end of summer, which begins in the second half of the month. Most plants have completed their blossoming, great willow herb seeds float through the forest like white down. Some spring plants blossom again. Yellow streaks begin to appear in the foliage toward the middle of August, while by the month of September the entire forest bursts into the hues of the golden autumn. There may be ground frost in August, and in the dark night sky play the greenish streaks of the Northern Lights.

Some July species still fly in small numbers: Ch. virgaureae, A. aglaja, L. donzelii, garden pierids begin to appear: P. brassicae, P. rapae, P. napi, hibernating nymphaliids: V. urticae, V. antiopa, Polygonia c-album, as well as the second generations of certain butterflies: L. astrarche, L. argiolus.

In September, as everything fades and dies, it is possible to find the same August butterflies, but in smaller numbers. In October the permanent snow cover appears, but in certain years a temporary snow cover may appear in the second half of September.

List of Rhopalocera

1. Papilio machaon L. VI-VII. Not frequent; was very common in 1955. From the caterpillars collected during that summer, and which pupated, six months later were obtained not butterflies, but ichneumon flies of the tribe Cryptini. During 1956-1957 swallowtail butterflies were hardly encountered.

2. Aporia crataegi L. VI, rarely during VII. Rare. Became more abundant from 1954.

3. Pieris brassicae L. VI and VIII-IX. Common. Damage negligible.

4. P. rapae L. VI and VIII-IX. More common than the preceding one, sometimes causes noticeable damage to cabbage.

5. P. napi L. V-IX. 2 generations. Very common in the latter half of summer.

6. Euchloë cardamines L. V-VI. Common.

7. Gonopteryx rhamni L. VIII. Very rare.

8. Leptidia sinapis L. V and VI-VII. 2 generations. Very common.

9. Colias palaeno L. VII-VIII. Very common.

10. C. hyale L. VIII, rarely and IX. Not frequently seen.

11. Callophrys rubi L. IV-V. Very common.

12. Chrysophanus virgaureae L. VII-VIII. Very common.

13. Ch. hippothoë L. VII. Very rare.

14. Ch. amphidamas Esp. IV-VII. Very extended flying period. Very common.

15. Lycaena argiolus L. VI and VIII. 2 generations. Very rare. Damp meadow with springs on a river bank; very stony river bank with sparse grass covering; turf swamp covered with wild rosemary and dwarf birch.

16. L. eumedon Esp. VI. Very common. L. e. ab fulgia Spangb. VI. Common.

17. L. astrarche Brgst. VI-VII and VIII. Sometimes also IX. 2 generations. Very common.

18. L. semiargus Rott. VI-VII. Very common.

19. L. icarus Rott. VI-VII, in some years also VIII-IX. Very common. L. i. ab. icarinus Scriba. As above. Not frequent. L. i. ab. caerulea Fuchs. as above. Not frequent. L. i. m. pusilla Gerh. VIII-IX. Rarely.

20. L. donzelii B. VII. Very common.

21. L. optilete Knoch. VI-VII. Very common.

22. L. aegon Schiff. VI-VII. Very common, but found only along river banks, sandy hills covered with Euphorbia esula L.

23. L. argus L. VII. Very rare. Damp meadows.

24. Vanessa antiopa L. V and VIII-IX. Very common. V. a. ab. hygiaea Hb. VIII-IX. Rarely.

25. V. urtica L. IV-V and VIII-IX. Not frequently seen.

26. Polygonia c-album L. V and VIII-IX. Common.

27. Pyrameis atalanta L. VII. Only 1 specimen 10 VII 1950.

28. P. cardui L. VI and VII-VIII. Very common, especially in 1952 and 1957.

29. Araschnia levana L. VI. Very rare. Only spring generation, summer generation absent. Along river and lake shores, with a vegetation of horsetails and sedge.

30. Melithea athalia Rott. VI-VII. Common.

31. M. dictynna Esp. VI-VII. Common.

32. M. maturna L. VI. Common. M. m. m. uralensis Stgr. VI. Not frequent.

33. Brenthis pales Schiff. arsilache Esp. VI-VII. Very common. Br. p. m. lapponica Stgr. VI-VII. Rare.

34. Br. frigga Thnb. VI. Only 1 specimen 26 VI 1950.

35. Br. euphrosyne L. VI. Very common. Br. e. ab. melanotia Spul. VI. Rare.

36. Br. selene Schiff. VI-VIII. Very common.

37. Br. aphirape Hb. ab. ossianus Hbst. VI. Only 1 specimen 26 VI 1950.

38. Br. freja Thnb. VI. Not frequent.

39. Br. amathusia Esp. VII. Common.

40. Argynnis ino Rott. VII. Very common.

41. A. latonia L. IX. Only 1 specimen 18 IX 1955.

42. A. aglaja L. VII-VIII. Very common.

43. Erebia euryale var. euryaloides Esp. VII. Very common.

44. E. ligea L. VI-VII. Very common.

45. E. embla Thnb. VI. Not frequent.

46. E. disa Thnb. VI. Rare.

47. Oeneis jutta Hb. VI. Common. Damp spruce – green moss and pine – green moss groves.

48. Pararge hiera L. VI. Common.

49. Coenonympha tiphon Rott. VII. Common.

50. Pamphila palaemon Pall. VI. Common.

51. P. silvius Knoch. VI. Common.

52. Hesperia carthami Hb. VI. Common.

53. H. alveus L. VI-VII. Common.

54. H. serratulae H.-S. VI-VII. Common.

SUMMARY

This paper is the first review on diurnal butterflies not only of the Ukhta district but of the whole Komi Autonomous Soviet Socialist Republic. Fifty-four species of diurnal butterflies with 8 subspecies found in the district mentioned above are listed here. The dates of emergence of imago and the rate of occurrence of all the species are given. Where it is expedient the authors report some brief biological and ecological data. The material was collected by the authors during 11 years since 1946.

NEW GENERA AND SPECIES OF LEAF HOPPERS (AUCHENORRHYNCHA, JASSIDAE) FROM KAZAKHSTAN

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The leaf-hopper fauna of Kazakhstan has been studied only very superficially. While I was with the Kazakhstan expedition of the Institutes of Botany and Zoology AN SSSR during the summer of 1957, I was able to collect some leaf-hopper material, which included several dozen new species. Only the new genera, and the species belonging to them are described here, (all belonging to the tribe Euscelini). In addition to my own collection, I have used also some material from the collections of the Institute of Zoology, AN SSSR, for the descriptions; these specimens have been previously in the hands of A. A. Zakhvatkin, who had not wholly completed their identification. I. A. Chetyrkina has helped to decipher some of the labels.

Types and paratypes of the species described here are in the collection of the Institute of Zoology AN SSSR.

Calamotettix Emeljanov, gen. nov.

Body narrow, very slender. Head with eyes hardly wider than the pronotum. Vertex twice as short as it is broad between the eyes, its anterior border slightly obtuse-angled, rounded, posterior border with the eyes moderately concave. Frontoclypeus flat. Anteclypeus elongate, with concave lateral borders. Frenula small with rounded apexes, their internal borders in contact with the anteclypeus for $^3/_4$ of their length. Inner borders of eyes with a recess opposite the bases of the antennae. Ocelli large, almost touching the eyes, immediately below the ocelli begins a sature which divides the frontoclypeus from genae. Pronotum $1\frac{1}{2}$-2 times as long as the vertex, its anterior border is moderately convex, lateral borders with rather widely rounded posterior corners, posterior border slightly concave. Scutellum large, a little shorter than the pronotum, $^1/_3$ as narrow as the latter, with straight edges, with a distinct transverse line in the middle. Elytra long, about $^1/_6$ of their length ($\frac{1}{2}$ of the length of the membrane), extends beyond the apex of the abdomen. Vein M−Cu present. Posterior femora spine formula: 1 + 2 + 2.

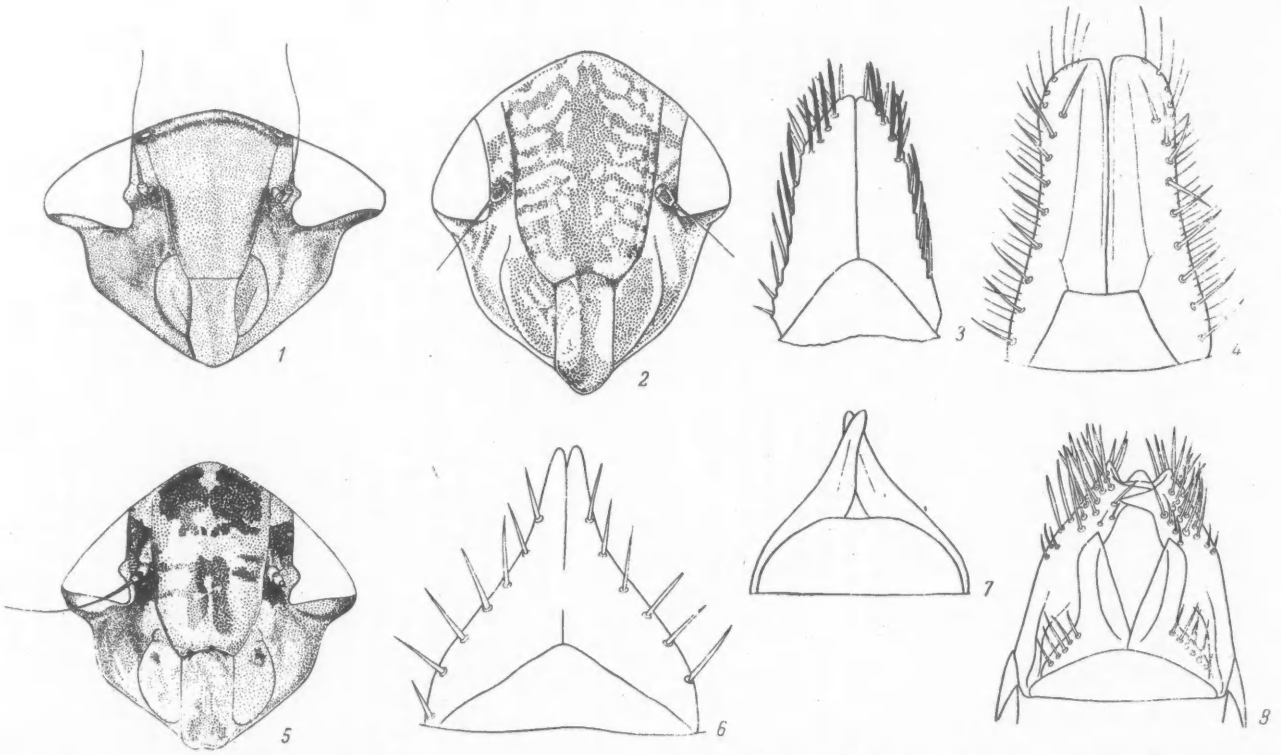
Female pygophore with sparse, long bristles. Ovipositor may or may not protrude beyond the pygophore.

Male pygophore long, its dorsal side from behind with a recess, occupying $^2/_3$ of its total length. Sections of the pygophore with rather dense, long bristles, below with delicate hairs, with a dorsally directed tooth in the middle of the inner surface. Anal tube occupies the anterior half of the recess of the pygophore, its dorsal surface not sclerotized. Genital valve trapezium-shaped. Genital plates with a single row of bristles near the external border, long, their length more than twice exceeding their breadth at the base, with longitudinal furrows in the middle, their inner borders in contact with each other, only slightly diverging before the apex, the apexes broadly rounded, outer borders concave, parallel in the apical half. Stylus long, its apex bent outward at a right angle. Connective noose-like. Penis short, its base broad, flat, with a recessed upper border, the stem of the penis flat, curved in front of the middle toward the base at an acute, almost a right angle.

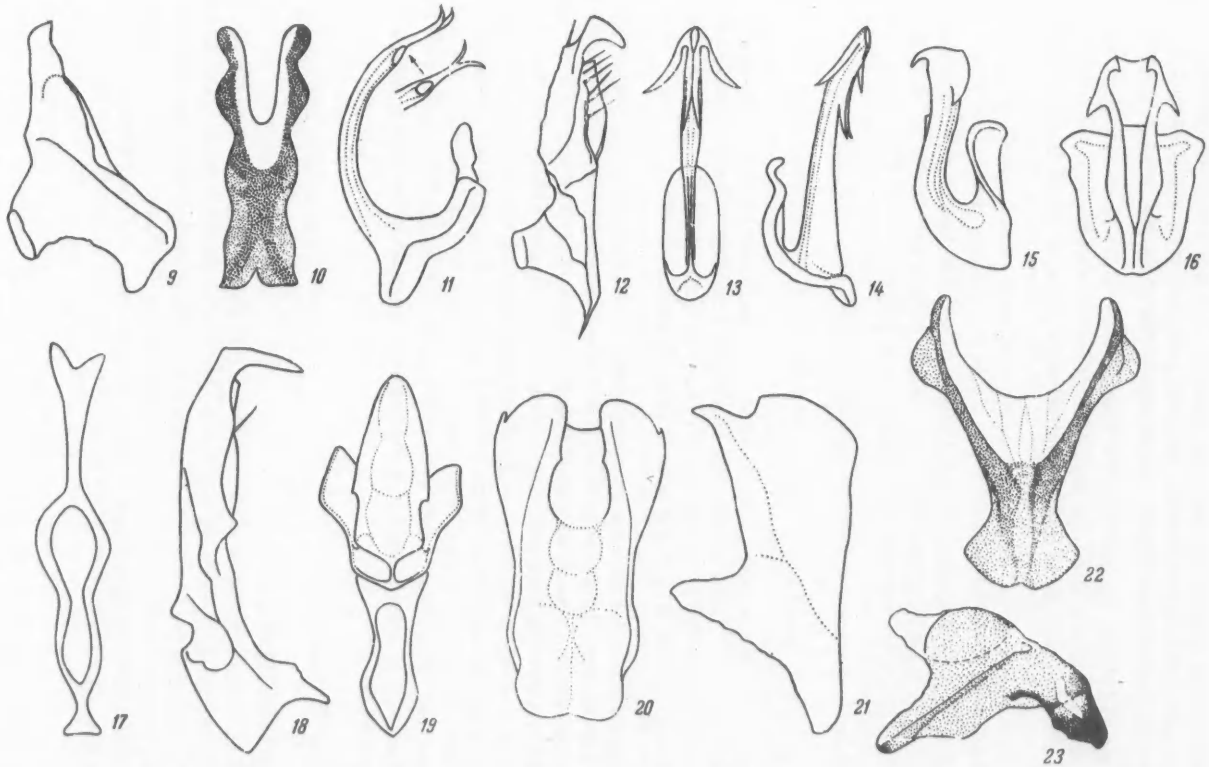
Type species Calamotettix viridescens Em., sp. n.

Calamotettix viridescens Emeljanov, sp. n.

Vertex pale green with a black line along the anterior border, with a longitudinal black line, disappearing



Figs. 1-8. 1) Calamotettix viridescens, gen. n., sp. n., frons; 2) Achaelica anabasidis, gen. n., sp., n., frons; 3) Chloothea zonata, gen. n., sp. n., genital valve and genital plates; 4) Calamotettix viridescens, gen. n., sp. n., genital valve and genital plates; 5,6) Condylotes zachvatkini, gen. n., sp. n., 5) frons, 6) genital valve and genital plates; 7) Achaetica anabasidis, gen. n., sp. n., genital valve and genital plates; 8) Cleptochiton variegatus, gen. n, sp. n., male anal region, ventral view.



Figs. 9–23. 9, 10, 11) Condylotes zachvatkini, gen. n., sp., n., 9) left stylus from above, 10) connective, 11) penis, lateral view; 12, 13, 14) Chloothea zonata, gen. n., sp. n., 12) left stylus from above, 13) penis from behind, 14) penis, lateral view; 15, 16, 17) Cleplochiton variegatus, gen. n., sp. n., 15) penis, lateral view, 16) penis from behind, 17) connective; 18, 19) Calamotettix viridescens, gen. n., sp. n., 18) left stylus from above, 19) penis and connective; 20, 21, 22, 23) Achaetica anabasidlis, gen. n., sp. n., 20) penis from behind, 21) penis, lateral view, 22) connective, 23) left stylus from above.

in front, in the middle. Frons pale, with a narrow black line above, frontoclypeus dark. In individuals which are more weakly pigmented, (holotype), the head pattern is reduced to two parallel dark brown lines, which proceed along the border between the frons and the vertex. Pronotum pale green, about 1½ times as long as the vertex, slightly striated transversely in the posterior $^2/_3$. Scutellum pale green, lighter colored along the midline. Elytra pale, faintly greenish, translucent, with pale, milky white veins. Ventral side of the body pale. Legs pale, with blackened apexes of the second and third segments of the tarsi, sometimes with black spots at the bases of the bristles. Dorsal side of the abdomen black with pale green longitudinal lines on the sides and in the middle. Posterior internal angles of tergites. (on the ventral side of the abdomen), blackened.

The last sternite of the female darkened from the posterior edge, with a recess on the posterior edge, laterally bordered by protrusions with rounded tips, the middle of the recess with a small wavy protrusion. Base of female pygophore with a black spot on the top. Ovipositor hardly protrudes beyond the pygophore, black on its sides.

Length of male 4.5 mm, females 5-4.8 mm.

Material: 1 male (holotype) – Akmolinsk Region, small hill region Kokshetau, 6 VII 1957 (Emel'yanov); 8 females – Akmolinsk Region, Kokshetau, 29 VI 1957 2 specimens, 1 VII, 2 VII, 12 VII, 14 VII 1957; river Terisakkan valley near Kokshetau, 11 VIII 1957, 2 specimens (Emel'yanov).

The species is found in relation to the reed Phragmites communis Trin.

Cleptochiton Emeljanov, gen. nov.

Externally resembles Sorhoanus medius M. R. Head with eyes somewhat wider than pronotum. Length of vertex equal to that of pronotum. Width of frons with eyes equal to its length. Frontoclypeus narrow, twice as long as it is broad, anteclypeus twice as short as frontoclypeus, with parallel sides, twice as long as it is wide. Elytra longer than abdomen. Formula of spines on apex of posterior femora: 1 + 2 + 2.

The pygophore dorsally with a deep indentation, occupying $^2/_3$ of its length. Segments of the pygophore covered by dense long bristles, with slightly narrowed bases and broadly rounded apexes, bearing below strongly sclerotized, mutually criss-crossing teeth. Anal tube, as long as a pygophoral segment, laterally compressed toward its apex. Genital valve broad, transverse, shaped as an isoceles triangle with a rounded apex, pointing backward Genital plates reaching to the middle of the pygophoral segments, their internal edges divergent, external edges sharply bent in the middle and convex, and have an acute, sharp apex. An oblique row of bristles in the basal portion of the genital plates is parallel to the basal portion of their external edge. Stylus short, simple. Connective very long, noose-shaped. Base of penis broad, the stem originates from its lower portion, moderately short, with a large gonopore, curved with the convexity backward in the basal portion, and with backward-pointing teeth on the apex.

Type species Cleptochiton variegatus Em., n. sp.

Cleptochiton variegatus Emeljanov, sp. n.

Plan of the pattern identical to that of Diplocolenus frauenfeldi Fieb. Frons pale, with a slight yellowish-green tinge, sutures darkened, frontoclypeus dirty brown with light colored transverse lines. Spots on vertex and pronotum dirty brown, on the latter grouped into four longitudinal bands. Two dark indistinct spots and a darkened furrow on the scutellum. Thorax and legs pale, brownish, with indistinct dark spots. Elytra with indistinct milky white veins and with cells bordered by dirty brown indistinct bands or lines. Abdomen subdued yellow-green, middles of tergites and sternites black.

Female unknown.

Length of male 3.2-3.4 mm.

Material: 3 males – Akmolinsk Region, Kokshetau, 29 VI 1957; 10 km north of Lake Zharkol' (north), 30 VI 1957, steepe; same place, 9 VIII 1957, more to the west in the steppe (Emel'yanov).

On Anaurolepidium ramosum Nevski, etc.

Chloothea Emeljanov, gen. nov.

Frons with eyes triangular, somewhat wider than the pronotum, smooth, flat or slightly concave, with a longitudinal furrow in the middle, disappearing anteriorly, apex narrowly rounded, lateral sides of the anterior border slightly or considerably convex, posterior edge with the eyes deeply incised in a curve. Vertex longer in the females than in the males. Frons and vertex, when regarded from the side, form an acute angle; the transition from the vertex to the frons is sharp and rounded. Frons with dense small dots. Frontoclypeus 1½ times as long as it is wide, slightly flatly compressed in the middle. Anteclypeus with parallel sides, 1½ times as long as it is wide. Frenulae as long as the anteclypeus, almost along the entire length of their internal border in contact with the latter, only their apex touches the frontoclypeus. Borders of genae slightly convex, with a distinct incision underneath the eyes. Eyes with recesses opposite the bases of antennae. Antenna with flagellum as long as the frontoclypeus. Labium short, hardly reaching to the apexes of anterior trochanters. Anterior border of pronotum very convex, lateral borders short, posterior border with two convexities, divided in the middle by a recess. Scutellum twice as narrow and half as long as the pronotum, with a distinct transverse line in the middle. Elytra of short-winged individuals, together are 1½ times as long as they are broad, do not cover the 2 or 3 last tergites and pygophores, somewhat obliquely truncate at the apex, with rounded angles. Elytra of full-winged females usually slightly shorter than the abdomen. Veins in the basal portion of elytra indistinct, clavial suture distinct. Veins R and M of the wing merge into a common stem before reaching the apex. Formula of spines on apex of posterior femora : 1 + 2 + 2.

Female pygophore with few bristles, in groups and singly, in front of the apex with three dense clusters of long bristles on either side, placed one on top of the other. Ovipositor somewhat protruding beyond the pygophore.

Male pygophore wide, its dorsal side posteriorly with a right-angled incision, reaching to half the length of the pygophore. Near the anterior angles of the incision there are two dense clusters of long bristles, and another similar cluster is found in the middle of each segment of the pygophore. Two small groups of bristles on the sides of the base of the pygophore, below. Anal tube short, does not reach to the apex of the pygophore and genital plates. Genital valve triangular, transverse, its base almost twice as narrow as the last sternite. Genital plates near the external border with a single row of bristles, doubled for a short distance near the apex, 3 times as long as the valve, close to each other, their external borders moderately concave, convex in front of the apex, apexes acutely rounded. Stylus moderately wide with rather a narrow L-shaped apex, with several bristles near the external border, lies within a space of a shape similar to itself, in the genital plate. Stem of the penis almost straight near the base, at the apex bears outgrowths directed toward the base. Gonopore apical.

Type species Chloothea zonata Em., sp. n.

The genus is well distinguished from the others by the chaetotaxy of the pygophore. Deltocephalus warioni Put. from Algeria probably belongs to this genus.

Chloothea zonata Emeljanov, sp. n.

Vertex pale greenish yellow, shiny, with a thin black line along the anterior border, sometimes reduced to two triangular spots near the apex of the vertex, flat or somewhat concave in front of the middle, lateral sides of the anterior border moderately convex. Frons dull, dark brown to black with light spots or their traces on frontoclypeus, forming several transverse rows, interrupted in the middle. Thorax black, dull. Coxae black, femora black with light apexes, tibiae light with dark coalescent spots, first and second tarsal segments with light bases and dark apexes, third segment black. Prontoum, scutellum and elytra pale greenish yellow. Apexes of elytra blackened by a transverse band, this band being narrow in short-winged individuals, broad in full-winged females, occupies about $^{1}/_{6}$ of the length of the elytra. Abdomen brown to black, light above. In females the posterior border of the last sternite white, white traces on the posterior border of the penultimate sternite, certain bristles below, on the pygophore are white. The following structures are white in the males: posterior border of last sternite, middle parts of posterior borders of the two preceding ones, last tergite and clumps of bristles on either side of the base of the pygophore.

Length of males 2.6-2.4 mm, females 3.4-3.3 mm.

Material: 21 males, 5 females, – Akmolinski Region, 6 km NE of Lake Ilektykol', 21 VI.1957, 1 short-winged female (allotype), 25 VI, 6 males (holotype and paratypes), 27 VI, 5 males; 1) km N of Lake Zharkol' (south),

30 VI, 8 males, 8 VIII, 1 male; Kokshetau, 29 VI, 1 full-winged female; river Kipchak, 50 km from Kokshetau, 3 VII, 1 short-winged female (Emel'yanov). Near Aktyubinsk, 20-21 VII 1937, 1 male (labeled "Beybienkoa pulchra, n.g., n.sp. Zachvatkin det."). Kustanaiskaya region, Lavrent'evka, 2.6 VIII 1937, full-winged female (labeled: "Beybienkoa pulchra Zachv.", G. Ya. Bei-Bienko, L. A. Chetyrkina). Transbeikalia mer.-occ., Fl. Dzhida, Enchor, 20 VII 1928, 1 short-winged male (Th. Lukjanovitsh).

In addition to this species is known from the Naurzum preserve under the name (nom. nud.) Bejbienkoa (sic!) pulchra A. Z. (Kamenskii, 1949).

The species is adapted to steppe cereals, especially to Festuca sulcata Hack.

Condylotes Emeljanov, gen. nov.

Body short, cylindrical. Head with eyes as wide as pronotum. Vertex broad, convexly rounded in front, wide-angled, twice as broad as it is long. Transition from vertex to frons gradual. Frontoclypeus more than 1½ times as long as it is broad, with parallel sides above the antennae, noticeably narrowing toward the anteclypeus. Anteclypeus with parallel sides, twice as short as the frontoclypeus, twice as long as it is wide. Frenulae bordering with frontoclypeus along $^1/_3$ of their internal border. Edges of genae with a large recess below the eye. Internal borders of eyes with a recess opposite the base of the antennae. Rostellum long, somewhat longer than the anteclypeus. Antenna with flagellum as long as the frontoclypeus. Pronotum slightly longer than the vertex, uniformly convexly rounded in front, with short lateral edges which are rounded, with the posterior edge protruding in the shape of a trapezium, with rounded corners and slightly concave middle part. Elytra leathery, with a network of accessory veins, which are denser on the clavus. Vein M-Cu present. Elytra in short-winged individuals reach to the last sternite and in full-winged females to the pygophore. Formula of spines on apex of posterior femora: 1 + 2 + 2.

Pygophore of female somewhat shorter than half the length of the abdomen from below; pygophore below with sparse, short, sharp bristles.

Pygophore of male dorsally incised in a right angle to half its length, including the segments. Anal tube small, slightly laterally compressed, completely enclosed in the recess of the pygophore. Segments of the pygophore with bristles. Genital valve transverse, triangular. Genital plates, which are in close contact with each other, with a single row of bristles near the concave external border, their apexes acutely rounded, separate. Genital valve and genital plates together form approximately an isoceles triangle. Apexes of pygophoral segments reach beyond the apexes of genital plates. Stylus short, with a recess below, in front of the apex. Connective forked. Base of penis more developed in the upper portion, the stem convexly curved backward Gonopore subapical on the anterior side of the stem.

Type species Condylotes zachvatkini Em., sp. n.

Condylotes zachvatkini Emeljanov, sp. n.

Vertex pale sandy colored with six dirty brown spots near the anterior border, with a transverse spot in the middle and five spots near the posterior border. Frons pale sandy colored. Frontoclypeus above with two touching large black spots with uneven outlines and with a more or less developed pattern, consisting of transverse, dirty brown lines. Genae near bases of antennae black, sometimes also black beneath the eyes. Frontal sutures black. Anteclypeus with a dark spot near the apex. Frenulae with darkened upper angles, sometimes completely black. Pronotum with a mottled pattern consisting of dirty brown spots, which are bigger and sparser near the anterior border, on a pale sandy colored background. Scutellum with a dirty brown, indistinct spot at the base and with two widely separated small spots near the middle. Elytra dirty brown with dirty milky white veins and a light colored band along the clavus suture. Thorax with black spots. Abdomen pale sandy colored with an indistinct dark pattern. Base of pygophore of male with two black spots along the sides. Posterior border of last sternite of females with two recesses, divided by a biapical protrusion.

Length of males 3-3.8 mm, of females 3.9-4.4 mm.

Material: 20 males, 9 females – Akmolinsk Region Kokshetau, 29 V-13 VIII 1957, 5 males, 3 females; 10 km north of Lake Zharkol' (south), 17 VI-9 VII 1957, 3 males, 2 females; River Shabdar, 5 km west of meteorological station, 21 VI 1957, 3 males; 6 km northeast of Lake Ilektykol', 25-27 VI 1957, 7 males, 2

females (male holotype, allotype and paratypes); River Terisakkan near Kokshetau, 13 VI 1957, 1 female; River Zhamankon, 4 VII 1957, 1 male; Baizhanzhal, 7 VII 1957, 1 male (Emel'yaniv) Orenburg region, village of Caverovskii, 23 VIII 1936, 1 female (labeled "Allygus brevissimus sp. n. Zachvatkin det.", I. A. Chetyrkina).

In addition to this, this species is known from the Naurzum reserve under the name (nom. nud.) Allygus brevissimus A. Z. (Kamenskii, 1949). Apparently this is a widely distributed steppe and semidesert species. Found on chamomile Pyrethrum kasakhstanicum Krasch., etc.

Achaetica Emeljanov, gen. nov.

Body short, cylindrical. Head with eyes a little narrower than the pronotum. Vertex convex or with a furrow near the anterior border, in front obtusely or evenly rounded, behind, recessed, including the eyes, between the eyes hardly wider than it is long in the middle. Frontoclypeus somewhat longer than it is wide between the antennae. Anteclypeus long, with parallel sides, rounded or recessed at the apex, equal approximately to $^2/_3$ $^1/_3$ the length of the frontoclypeus, 2½ times as long as it is broad. Frenulae large, half of their internal border bordering with the frontoclypeus. Edges of genae almost without recesses beneath the eyes, convexly and obtusely curved in the middle. Pronotum short, approximately twice as short as the vertex, its anterior border widely convexly curved in the middle, lateral borders divergent, posterior border concave. Scutellum very small, its base more than 7 times narrower than the pronotum. Elytra very short, slightly obliquely truncate, rounded, together approximately twice as broad as they are long, leathery, reach to the II-III sternite of the abdomen. Venation and clavus suture indistinct. Formula of spines on apex of posterior femora: 1 + 2 + 2.

Female pygophore large, occupies $^2/_3$ of the length of the abdomen below, devoid of large bristles. Ovipositor protrudes beyond the pygophore.

Male pygophore short above, narrows toward the apex, posteriorly on the dorsal side with a right-angled recess, occupying one third of its length. Segments of the pygophore touch each other below, behind the apexes of genital plates. Anal tube small, entirely within the pygophoral recess. Genital valve transverse, broad, with a straight base, with posterior and lateral borders acutely rounded. Genital plates without bristles, with internal borders more or less encroaching upon each other, narrow and thick with concave external borders, or flat, simple, with convex external borders. Stylus short, its apex obliquely truncate and sharply bent outward Connective forked. Penis short, thick. Anterior side of the stem reduced, posterior side membranous, lateral sides sclerotized, resembling lobes.

Type species Achaetica anabasidis Em., n. sp.

Achaetica anabasidis Emeljanov, sp. n.

The entire insect shiny, brown with indistinct black and light spots. Vertex convex, often with a large dark spot occupying its apex; this spot is sometimes divided into four spots, or is expressed as a transverse line which is interrupted in the middle. Two additional dark spots at the base of vertex, one on each side. Frons brown to entirely black, often with a pattern of transverse lines on the frontoclypeus. Pronotum often with two dark spots behind the eyes. Elytra without spots, sometimes with a dark pattern which defines the veins. Thorax and coxae dark brown to black, femora light brown with dark bases and constricted in front of the apex; tibiae and tarsi light brown. Abdominal tergites dark brown to black, each with ten light spots, which form, on the whole, longitudinal rows. Abdomen below light brown to dark brown with lighter posterior borders of sternites. Base of genital valve black.

Length of males 2.4-2.8 mm, of females 2.9-3.6 mm.

Material: 15 males, 7 females – Akmolinsk Region, Bosaga-ozek, 13 VII 1957, 13 males, 4 females (holotype male, allotype and paratypes); Kokshetau, 14 VII-14 VIII 1957, 2 males, 3 females (Emel'yanov).

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NOTES ON THE COCCOIDEA OF CHINA.

VII. A NEW FAMILY OF COCCOIDEA, LECANIODIASPIDIDAE, FAM. N. (HOMOPTERA).

THE SCIENTIFIC RESULTS OF THE CHINESE-SOVIET EXPEDITIONS OF 1955-1957

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The separation of Lecaniodiaspididae from the family Asterolecaniidae into a separate family is considered necessary by us due to the developed anal cleft of the females. The presence of the anal cleft points to the close relationship of the representatives of the families Lecaniodiaspididae and Coccidae. According to the more primitive structure of the posterior end of the abdomen, which ends in anal segments, the females of Asterolecaniidae are closer to the females of Eriococcidae than to the females of Lecaniodiaspididae. The developed anal segments point to an earlier separation of the ancestors of Asterolecaniidae from the branch which includes the modern families Lecaniodiaspididae and Coccidae. The division between Lecaniodiaspididae and Coccidae probably took place much later, when the females of ancestral forms developed a specific structure, i.e., the anal cleft.

The paired glands of the females of Lecaniodiaspididae show that this family is close to Asterolecaniidae; it was mainly this consideration which resulted in our combining these two groups into a single family. However, the paired glands differ in structure in these two families. The paired glands are more specialized in the females of Asterolecaniidae; this may be explained by an earlier separation of Asterolecaniidae from the ancestral forms of Lecaniodiaspididae-Coccidae and by the development of the specific protective integuments.

Small paired glands are also characteristic of females of other families of Coccoidea, e.g., some Coccidae.

Fam. Lecaniodiaspididae, fam. n.

Female. External integument firm, but elastic; segmentation apparent only on the ventral body surface; up to 9 mm in length. Antennae developed, number of antennal segments 7 to 10. Legs developed, reduced or wholly absent. Abdominal spiracles absent. Posterior end of abdomen divided by the anal cleft; strongly chitinized anal plates present on either side at the base of the anal cleft. Anal ring well developed, bearing setae and pores; it is within the anal tube, the edge of which is strongly chitinized. Wax glands of varying structure; the curved, small paired glands are the most characteristic; small paired, tubular and discoid glands of varying shapes, and discoid pores are often developed.

Female integument is firm, often decorated in different ways.

The family Lecaniodiaspididae includes approximately 60 species which belong to 7 genera. In addition to the two new genera, Psoraleococcus, gen. n. and Cosmococcus, gen. n., whose description is given below, the family includes the following genera: Lecaniodiaspis Targioni-Tozzetti (1869), Prosopophora Douglas (1892), Mallococcus Maskell (1898), Amorphococcus Green (1902), and Anomalococcus Green (1902).

The genus Birchippia Green (1900), soon after publication was included among the synonyms of the genus Lecaniodiaspis Targ. The question of the validity of the genus Birchippia Green must be reconsidered.

Fig. 1. Psoraleococcus verrucosus Borchs., gen. et sp. n., females.

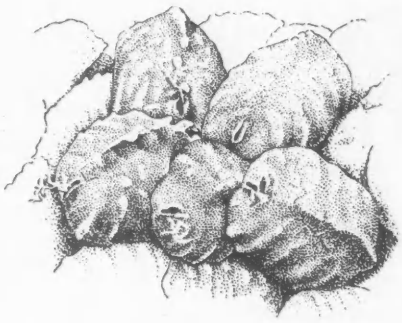

Fig. 2. Psoraleococcus costatus Borchs., gen. et sp. n. females.

The geographical distribution of the family includes all the parts of the world, being more concentrated in the Indo-Malayan region, (25 species).

Subfamily Lecaniodiaspidinae, subfam. n.

The description of the subfamily is the same as that of the family.

KEY TO GENERA

1 (12). Antennae fully developed, normally 7-to 10-segmented.

2 (11). Anal ring with 10-12 setae.

3 (10). With stigmatic spines.

4 (7). Without deep stigmatic clefts (Fig. 4).

5 (6). Marginal 8-shaped pores small: nearly as wide as dorsal 8-shaped pores . . . . . Prosopophora Dougl.

6 (5). Marginal 8-shaped pores large: nearly twice as wide as dorsal 8-shaped pores. . . . . Lecaniodiaspis Targ.

7 (4). With deep stigmatic clefts; spiracles stout, with short broad pore band (Fig. 3).

8 (9). With stigmatic spines . . . . . Psoraleococcus Borchs., gen. n.

9 (8). Without stigmatic spines . . . . . Anomalococcus Green.

10 (3). Without stigmatic spines. . . . . Cosmococcus Borchs., gen. n.

11 (2). Anal ring with 6 setae . . . . . Mallococcus Mask.

12 (1). Antennae rudimentary; gall-making insects . . . . . Amorphococcus Green.

DESCRIPTIONS OF NEW GENERA

Psoraleococcus Borchsenius, gen. n.

Adult female. Antennae 7-or 8-segmented. Legs absent. Spiracles large, near the sides of the body, body border concave; spiracular furrows short, sometimes grouped together; anterior furrows with two spiracular spines, posterior with one spine. Anal ring large, with pores and 10 setae; it is disposed within a small anal tube, whose anterior border is strongly chitinized and has the appearance of a half a ring. Paired glands very small, all strongly curved, numerous. Small uncurved paired glands are gathered into a band the edge of the ventral surface of the body. Tubular glands numerous on both the body surfaces. Multicellular (multilocular) glands present. Cribriform plates in groups or bands.

Outer integument of the female often with longitudinal and transverse ridges, up to 4 mm in length and 3 mm in width.

Type species — Psoraleococcus verrucosus Borchs., sp. n.

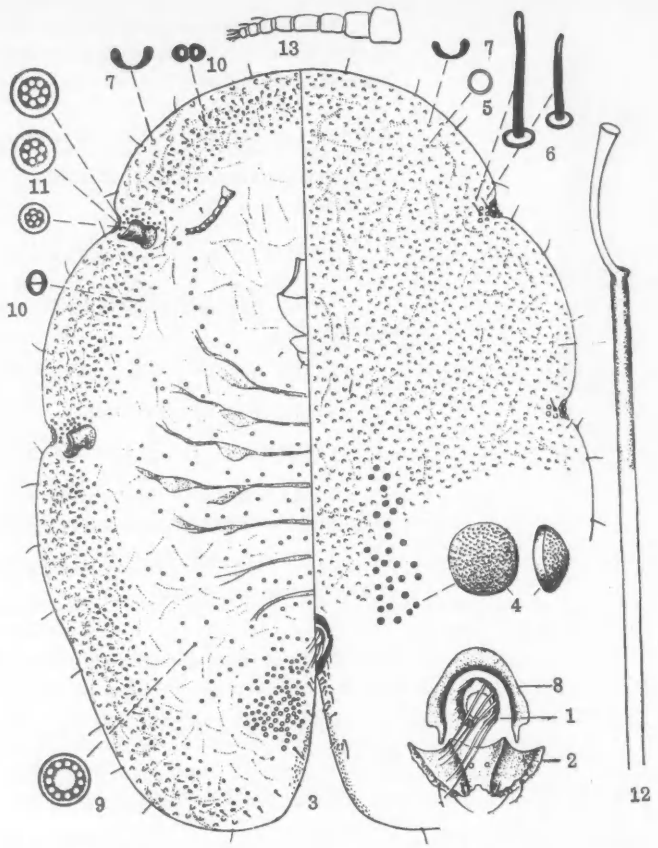

Fig. 3. Psoraleococcus verrucosus Borchs., gen. et sp. n., female: 1) anal ring; 2) anal plates; 3) anal cleft; 4) cribriform plates; 5) discoid pore; 6) spiracular spines; 7) curved, paired gland; 8) edge of anal tube; 9) multilocular gland; 10) paired gland; 11) five-locular gland; 12) tubular gland; 13) antenna.

KEY TO SPECIES

Genus Psoraleococcus Borchs., gen. n.

1 (2). Cribriform plates in two bands; anal cleft long; adult female flat (Fig. 1, 3). On stems of an undetermined plant, near Szemao, Yunnan province, China . . . . . Ps. verrucosus Borchs., sp. n.

2 (1). Cribriform plates in four groups; anal cleft short; adult female convex (Fig. 2). On the stems of an undetermined plant, near Szemao, Yunnan province, China . . . . . Ps. costatus Borchs., sp. n.

Psoraleococcus verrucosus Borchsensius, sp. n. (Fig. 1, 3)

Adult female. Body short, oval, flattened, about 2 mm in length and 1.5 mm in width. Antennae 7-or 8-segmented. Spiracles near the edge of the body, groups of glands terminating in spiracular spines. Anal cleft very long. Paired glands on the dorsal surface 4.5 μ long, slightly longer along the edge of the body, (5.0-5.5 μ). Tubular glands extremely numerous on the dorsal surface of the body and less numerous on the ventral. Multilocular glands grouped or in bands. Cribriform plates rounded, small, 17-20 μ in diameter, disposed in two large groups of 19-28 plates in each.

Female integument (Fig. 1) short, oval, flat, pinkish brown with white waxy plates, sometimes with transverse ridges, 3.0-3.5 mm in length and 2.0-2.5 mm in width or diameter.

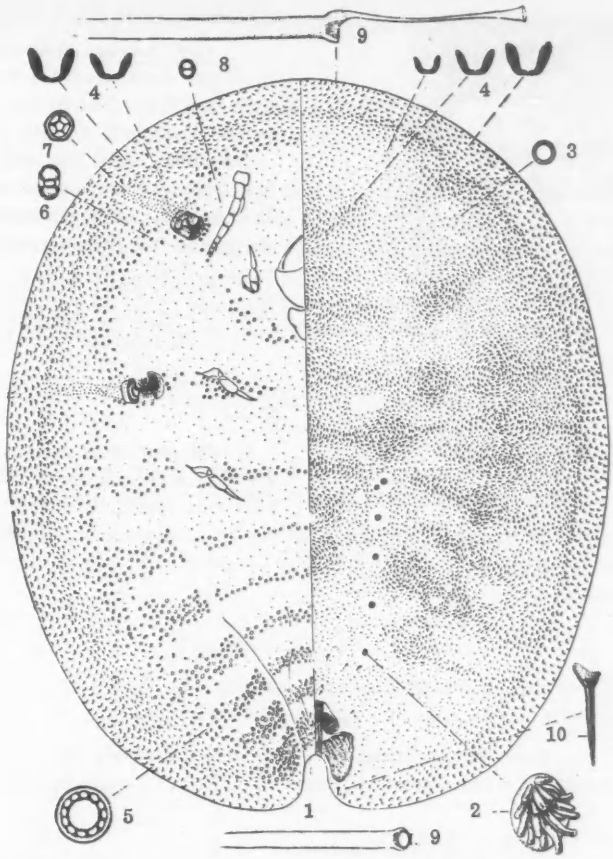

Fig. 4. Cosmococcus erythrinae Borchs., gen. et sp. n., female: 1) anal cleft; 2) cribriform plates; 3) discoid pore; 4) curved paired gland; 5) multilocular gland; 6) paired gland; 7) five-locular gland; 8) dark-framed, paired gland; 9) tubular gland; 10) spine.

China. Yunnan province: forest 8 km north of Szumao 22 V 1957 (N. Borkhsenius). Found on thin branches of a shrub whose identity has not been established.

Psoraleococcus costatus Borchsenius, sp. n. (Fig. 2)

Adult female. Body oval, 3 mm in length and 1.6 mm in width. Antennae 7-or 8-segmented. Spiracles near the body edge, spiracular furrows short and broad, terminating in a dense grouping of discoid glands and spines. Anal cleft short. Paired glands on the dorsal body surface 4.5 μ long, those along the body edge 6 μ long. Tubular and multilocular glands in about the same position as in the preceding species. Four groups of cribriform plates, two on either side of the body, the anterior groups consisting of 10-15 plates each, the posterior ones of 7-11 plates each.

Female integument (Fig. 2) oval, convex, dorsally in the middle with a distinct longitudinal ridge and numerous transverse ridges, yellowish brown or pinky buff in color, 3.5-4.0 mm in length and 2.5-3.0 mm in width.

China. Yunnan province: forest 25 km south of Szumao, 3 IV 1957 (N. Borkhsenius). Found on branches of a shrub whose identity has not been established.

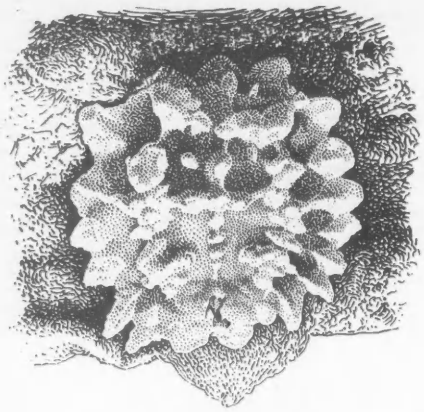

Fig. 5. Cosmococcus euphorbiae Borchs., gen. et. sp. n., female.

Cosmococcus Borchsenius, gen. n.

Adult female. Body oval, convex, up to 6 mm in length. Antennae 8- to 9-segmented. Legs developed, some of the members being often fused. Spiracular furrows developed, posterior furrows not bifid, spiracular spines absent. Anal ring with pores and with 10 bristles. Paired glands small, curved. Multilocular, tubular and dark-framed, paired glands developed. Cribriform plates disposed in two divergent rows.

Female integument convex, firm, covered by a layer of a secretory substance with white ornamentation, up to 9 mm long and 7 mm broad.

Type species – Cosmococcus erythrinae Borchs., sp. n.

The new genus is related to Psoraleococcus Borchs. The females are distinguished by the nature of their cribriform plates, the development of the spiracular furrows, and, (as also from the females of Birchippia Green), by the absence of the spiracular spines. The integument of the females of the new genus is characterized by the presence of a layer of a secretory substance and of white sculptured secretion.

KEY TO SPECIES

1 (2). Spiracle pore bands short, extended only ventrally (Fig. 4). On the stems of Erythrina indica Lam., near Mangshi, Yunnan province, China. . . . . C. erythrinae Borchs., sp. n.

2 (1). Spiracle pore bands long, extended on both surfaces of the body (Fig. 5). On the stems of Euphorbia splendens Bojer, near Pinchwan, Yunnan province, China . . . . . C. euphorbiae Borchs., sp. n.

Cosmococcus erythrinae Borchsenius, sp. n. (Fig. 4).

Adult female. Body short, oval (Fig. 4); immature females 3.0-3.5 mm in length. Antennae 8-segmented. Legs small, total length of posterior legs 0.25 mm. Spiracles large, disposed near the area occupied by the paired glands, spiracular furrows broad, short, do not reach to the dorsal body surface. Paired glands curved, small, in three sizes: approximately 4-5, 6 and 7-8 μ in length, numerous, disposed as shown in Fig. 4. Round pores encountered among the paired glands. Tubular glands disposed throughout both the body surfaces. Dark-framed paired glands in two sizes; the larger ones, 6 μ in length, are gathered in a band on the ventral body surface, below the edge of the body. Multilocular glands are gathered in groups on either side of the rostellum, behind the legs, and in transverse bands on the metathorax and abdomen. Five pairs of cribriform plates.

Female integument buff-colored with white ornamentation.

China. Yunnan province: Makshih, 17, V 1955 (T. Bushchik). Found on branches of Erythrina indica Lam.

Cosmococcus euphorbiae Borchsenius, sp. n. (Fig. 5).

Adult female. Body almost round, not very convex, 5.5 mm in length. Antennae 9-segmented. Legs small, thick, total length of leg 0.25 mm. All the spiracular furrows broad, reach on to the dorsal body surface. Paired glands curved, 7-8 μ long, numerous. Numerous small discoid pores among the paired glands. Tubular glands on both the body surfaces. Multilocular glands gathered in groups on either side of the rostellum, behind legs and in transverse bands on the metathorax and abdomen. Dark-framed, paired glands numerous on the ventral body surface. Cribriform plates large, 5 pairs in two rows.

Female integument (Fig. 5) moderately convex, dark buff in color with sculptured white ornamentation, 6-7 mm in length and 5-6 mm in width.

China. Yunnan province: Pinch'uan district, 29 VI 1956 (Shi Shan). Found on the fleshy stems of Euphorbia splendens Bojer.

SUMMARY

Family Lecaniodiaspididae, fam. n.

Adult female. Body derm entirely membranous except for appendages and anal structure; length to 9 mm. Antennae developed, normally 7-to 10-segmented. Legs present but poorly and faintly developed, sometimes reduced or wanting. Abdominal spiracles wanting. The caudal end of the abdomen with a distinct anal cleft; the sides of the anal cleft with two frequently fused anal plates; anal ring well developed, bearing long setae and pores; anal tube present, margin of the anal tube is heavily chitinized. 8-shaped pores of derm small. Tubular ducts large and numerous. Multilocular pores, spiracular disk pores and minute simple disk pores are present.

The test of the female oval or approaching subcircular, always high, or insects naked and gall making.

Subfamily Lecaniodiaspidinae, subfam. n.

The characterization of the family serves adequately for the subfamily as well. In this subfamily are included 7 genera and 25 species.

NEW SPECIES OF THE GENUS AEOLOTHRIPS HAL. (THYSANOPTERA, AEOLOTHRIPIDAE) FROM THE CRIMEA

N. N. Derbeneva

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Aeolothrips tauricus Derbeneva, sp. nov.

♀. Body length 1.32-1.45 mm. Body pale yellow, head brown, mouth cone pale; first antennal segment pale brown; second, third and base of fourth yellowish white; apex of fourth, and fifth segment, dark brown; sixth and seventh pale brown, apex of seventh paler, eighth and ninth white; prothorax pale yellow, almost white; pterothorax pale, yellowish brown. Legs slightly yellowish with a small distinct brown spot on the apex of first tarsal segment. Both pairs of wings transparent, colorless, with a brown fringe. Forewings distally with a dark brown cross band 180-200 μ long, with paler diffuse edges, proximally with an inconspicuous greyish cross band (Fig. 3); hindwings distally with an inconspicuous greyish cross band located $^{2}/_{3}$ of wing length from base (Fig. 4). Abdominal segments I-III white, IV-IX brown, X pale yellow, brownish on sides.

Head transverse, approximately .77 of length of pronotum. Basal segment of maxillary palps 1.3 times as long as two distal antennal segments taken together. Mouth cone long, approximately 160μ in length. Three ocelli between the large compound eyes; hind ocelli almost touching inner margin of eyes. Antennae (Fig. 1) 2.4-2.7 times longer than head; second segment a little longer than first and shorter than fourth, third the longest, pedicellate, cylindrical, narrower than second and fourth, 1.8-1.9 times longer than second and 1.1-1.3 times longer than fourth; fourth and fifth almost equal in length; sixth-ninth segments taken together approximately 6-7 times longer than sixth; third and fourth segments with elongated sensory areas, length of sensory area of third segment 30-32 μ, of fourth 25-30 μ; on the fourth segment the sensory area extends beyond the segment itself; on the fifth segment the sensory area is the base of a sense-cone and has the form of an elongated lentil of length 8.5 μ.

The wings reach the middle of abdominal segment VII; the forewings, apart from the two longitudinal veins, have four cross veins (Fig. 3); venation of hindwings simpler, only the base of one longitudinal vein noticeable (Fig. 5). Sutures of abdominal sternites III-IV, IV-V and V-VI in the form of a dark transverse line. Abdominal sternite VII with eight setae along hindmargin, these setae having the following lengths: b.1 and b.2 60 μ each, b.3 and b.4 40 μ each. Distance between setae b.1 and between setae b.2 and b.3 equal to 51 μ; between b.2 and b.3 34 μ, and between b.3 and b.4 25 μ (Fig. 8).

The main dimensions of the body are: length of antenna 316-354 μ; length and width (in parentheses) of antennal segments – 1 = 30-38 μ (20-30 μ), 2 = 48-51 μ (24-30 μ), 3 = 84-90 μ (19-20 μ), 4 = 68 μ (20-21 μ), 5 = 56-60 μ (20-21 μ), 6 = 15-17 μ (17 μ), 7 = 13 μ (13 μ), 8 = 8.5 μ (8.5 μ), 9 = 8.5-10.7 μ (4 μ); length of basal segment of maxillary palp 47 μ; length of two distal segments of maxillary palp taken together 34μ; length of prothorax 200 μ, width 227 μ; length of forewing 800 μ, width 250 μ; length of hindtibia 220-230 μ.

♂. Body length 1.0-1.1 mm. Body more slender, of smaller size and paler coloration than in female. Body color pale yellow; head slightly brown, antennae pale; apices of fourth and fifth segments slightly darkened; thoracic and abdominal segments pale yellow, almost white, abdominal segments IX-X dark brown; legs pale, with a dark spot on tarsi. Wings (Fig. 4) transparent, colorless, with dark fringe; forewing distally with a small

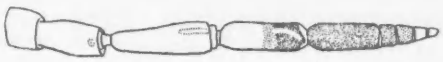
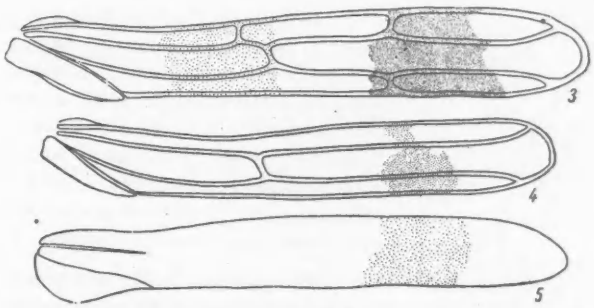


Fig. 1. Aeolothrips tauricus, sp. n., antenna of female.

Fig. 2. Aeolothrips tauricus, sp. n., antenna of male.

brownish cross band located at a distance of $^{2}/_{3}$ of wing length from base, this cross band being darker at hindmargin of wing; hindwing without cross bands.

Head transverse, approximately .9 of length of pronotum. Basal segment of maxillary palps equal in length to two distal segments taken together. Three ocelli between large compound eyes. Hind ocelli, as distinct from those of female, not touching inner margin of compound eyes. Antenna 2.1 times longer than head; second segment longer than first, but shorter than fourth; third segment longest pedicellate, cylindrical, narrower than second, but of same width as fourth, 1.6 times



Figs. 3-5. Aeolothrips tauricus, sp. n., wings: 3) forewing of female; 4) forewing of male; 5) hindwing of female.

longer than second and 1.3 times longer than fourth; fourth and fifth of almost equal length; sixth-ninth taken together (43μ) shorter than fifth (64 μ); fifth-ninth taken together approximately 8 times longer than sixth; third and fourth segments with elongate sensory areas (length of area on third segment 17 μ, on fourth 15 μ); fifth segment bearing distally a sense-cone, with base of length 8.5 μ (Fig. 2).

Wings reaching end of abdomen; forewing with one cross vein besides the two longitudinal veins (Fig. 4) and thus differing from that of female. Abdominal tergites III-V with small processes on hindmargin; a small triangular protuberance on each side of tergite III; tergite IV with an acute-angled plate, a rhomboid plate on V (Fig. 6). Segment IX with large, heavily sclerotized, hook-like process and a stout, sickle-shaped spine-seta (Fig. 7); both these processes are recurved.

The main dimensions of the body are: length of antenna 320 μ; length and width (in parentheses) of antennae segments — 1 = 34 μ (21-30 μ), 2 = 47-51 μ (21 μ), 3 = 77-80 μ (17 μ), 4 = 60 μ (17 μ), 5 = 60-64 μ (21 μ), 6 = 13 μ (15-17 μ), 7 = 13 μ (10.7 μ), 8 = 8.5 μ (8.5 μ), 9 = 8.5 μ (4 μ); head length 150 μ, width 150-155 μ; length of prothorax 170 μ, width 170 μ; length of forewing 720 μ, width 170-210 μ; length of hindtibia 200 to 210 μ.

Distribution: Crimea, south coast.

Material studied. Nikita Botanical Garden, 30 VIII 1954, 5 ♀♀, 3 ♂♂ (collection in alcohol, and mounts).* The species was collected on the flowers of Eryngium compestre L. We observed the mating of the males and females, and thus we had definite evidence of their belonging to the one species.

The type is preserved in the collection of the Zoological Institute, AN SSSR in Leningrad.

The described species, in shape of head, in antennal structure, in the number of segments on the maxillary and labial palps, in wing coloration and venation, and in the presence at the base of the foretarsi of a recurved hook with a triangular denticle at the base, belongs to the genus Aeolothrips.

*The material studied was collected by the author.

Fig. 6. Aeolothrips tauricus, sp. n., tergites III-V of male.

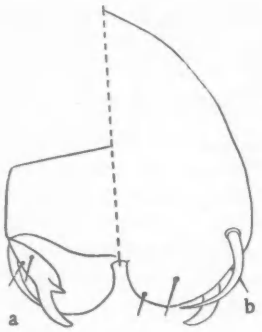


Fig. 7. Aeolothrips tauricus, sp. n., segment IX of male: a) tergite; b) sternite.

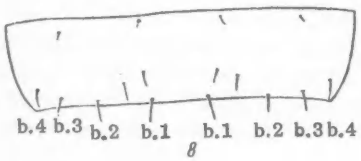


Fig. 8. Aeolothrips tauricus, sp. n., sternite VII of female.

In the genus Aeolothrips the new species is closest to the species A. gloriosus Bagnall (1914, 1920), described from Sardinia solely from females (male unknown) and A. montivagus Priesner (1948), described from males and females from Cyprus. All three species have a pale yellow body coloration and similar pale wings.

Besides this, A. gloriosus Bagnall resembles the described species in coloration of head, wing fringes and sutures of abdominal sternites III-IV, IV-V and V-VI, in the ratio of the length of the antennae to that of the head, equal to 2.5, and in the position of the hind ocelli. The described species also resembles the female A. montivagus Priesner in the coloration of the third-seventh antennal segments.

At the same time the female of A. tauricus differs distinctly from the females of A. gloriosus Bagnall and A. montivagus Priesner in the darker general coloration, dark segments IV-IX and pale abdominal segment X. In particular, the differences between the female of the new species and that of A. gloriosus Bagnall consist in the following: 1) larger body size; 2) third antennal segment entirely pale, fourth pale in basal half, eighth and ninth pale; 3) different proportions of antennal segments; 4) different coloration of forewings.

The described female differs from the female of A. montivagus Priesner in the following characters, besides the features already mentioned; 1) coloration of forewing; 2) longer forewing cross band; 3) shorter antennae, and also shorter wings, hindtibiae, and setae on segments IX-X; 4) narrower prothorax; 5) the position of the median and lateral setae on sternite VII.

The males of A. tauricus and A. montivagus Priesner differ very distinctly from one another: 1) in A. montivagus only abdominal segment X is very slightly darkened; in A. tauricus the apical half of IX, the whole of X and the whole of XI are distinctly black; 2) the antennae in A. tauricus have a different coloration from that in A. montivagus, and as a whole they are much paler in the former than in the latter; 3) in describing the male A. montivagus, Priesner noted that the wings were the same as in the female, while in the A. tauricus male the wing coloration and venation differed from that of the female; 4) in A. tauricus dorsal processes are present only on segments III-V, while in A. montivagus they are present on IV-VIII; there are also differences in 5) the structure of segment IX and 6) almost all the sizes given in the description of the species.

These three close species are found in the Mediterranean subregion (Sardinia, Cyprus, south coast of the Crimea). The recorded localities are few, and it is premature at present to assess their range.

The new species should be included in Priesner's (1948) key to the females of species of the genus Aeolothrips in the following way:

75 (76, 77). Three terminal abdominal segments dark. Apical half of fourth antennal segment and all subsequent, black. Bands on wings normal 1.1 mm . . . . . Ae. gloriosus Bagnall.

76 (75, 77). Abdominal segment X with darkened apex. First-third antennal segments pale, fourth with pale base. Bands on wings very short, partially fading out. 1.56 mm . . . . . Ae. montivagus Priesner.

77 (75, 76). Abdominal segments IV-IX entirely brown. X yellow. First antennal segment pale brown, second-third and base of fourth, eighth-ninth, pale; apex of fourth, fifth-seventh, brown. Wings with a single distinct, dark brown cross band distally and with an inconspicuous greyish band proximally. 1.32-1.46 mm ..... Ae. tauricus, sp. n.

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DESCRIPTION OF A NEW SPECIES OF THE GENUS ANISOSTICTA DUPONCH. (COLEOPTERA, COCCINELLIDAE)

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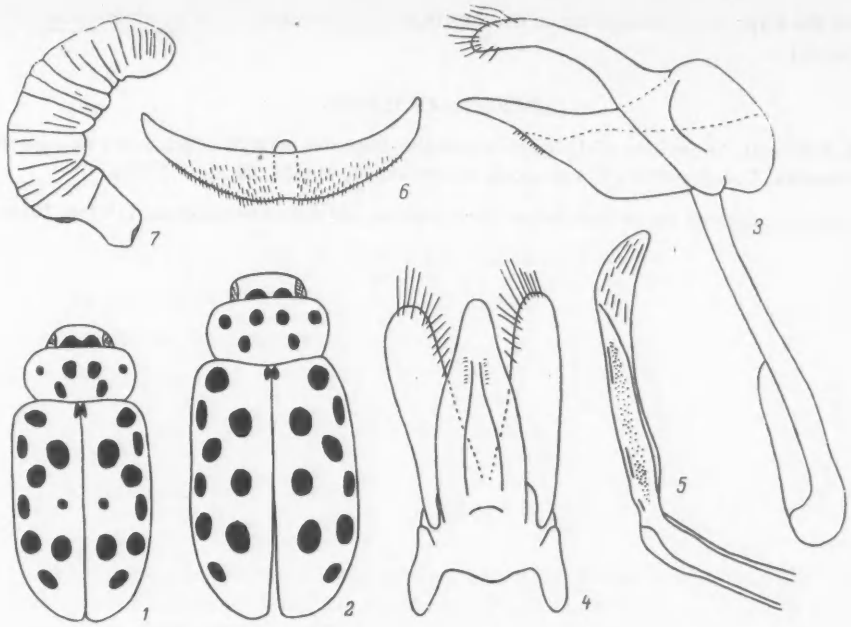
In spring 1958 I had the opportunity to visit the Zoological Institute AN SSSR in Leningrad and to acquaint myself with the rich collection of Palaearctic Coccinellidae kept there. I came across a large number of specimens belonging to the genus Anisosticta Duponch., which differed from the hitherto known species of this genus (Bielawski, 1958) by the longer and narrower body. A detailed investigation showed that they belonged to a new species not described so far. Thus, at present we know 6 species of the genus Anisosticta Duponch., including the recently described species Anisosticta sibirica Bielawski, 1958.

The new species, described below, occurs in Transbaikal and China, a region where the majority of species of this genus occur. This supports my suggestion (1958) that Siberia is the center of origin of species of the genus Anisosticta Duponch.

Anisosticta terminassianae, sp. n.

Holotype, male (Fig. 1). Body depressed, very elongated, lateral margins of elytra almost parallel, broadly rounded apically. Head brownish yellow with two black spots connected together at the basal margin. Mouth parts brown. Puncturation of head weak, punctures of same size as on pronotum; distance between punctures a little less than their diameter. Surface between punctures covered with a distinct reticulate microsculpture, the meshes being irregular and polygonal. Pronotum yellowish brown with 6 black, almost circular spots, of which the lateral spots are smaller than the spots on the disk. The lateral rim of the pronotum is narrow, hindmargin not emarginate. Punctures on pronotum smaller and much sparser than on elytra; distance between punctures equal to or a little greater than their diameter. Surface between punctures shining, covered with microsculpture consisting of indistinct, unequal, irregular lines. Scutellum small, triangular, black. Elytra long, narrow, brownish yellow, with 10 black spots on each. Of these spots the ones at each side of the scutellum are fused together to form a common spot at the base of the elytra. The arrangement of the other spots is the same as in Anisosticta novemdecimpunctata (L.), the spots being small, especially spot 6 [numeration according to Mader (1929)]. Spot 4 irregularly shaped, somewhat rounded. Spots 1, 3, 4, 7, 8 and 9 subequal, 2 and 5 also subequal, but smaller than the preceding ones. Humeral tubercles obsolescent, consisting of inconspicuous protuberances. Humeral angle and base of elytra regularly rounded, lateral margin very weakly and narrowly reflexed. Elytral punctures rather large, of equal size, arranged close to one another; distance between punctures approximately one third of their diameter. Surface between punctures shining, with traces of microsculpture consisting of barely visible lines radiating from the edges of the punctures. Prosternum white, with the exception of the hindmargin and the margins of its process, which are black. Mesosternum and metasternum black, except for center of mesosternum, mesepimera, metepisterna and metepimera, which are white. Epipleurae reach end of elytra; they are horizontal, sloping slightly toward end of elytra. Abdominal sternites yellowish, first three brownish black in center. Femoral line incomplete, extending only halfway along sternite. Last abdominal sternite with arcuate hindmargin, without tubercle. Legs brown. Body dimensions: length 3.7 mm, width 1.9 mm. Genitalia of ♂ given in Figs. 3 and 4. Siphon bent at almost a right angle at apex. Apex of siphon in Fig. 5. Penis and parameters of equal length. Penis very broad at base in lateral aspect (Fig. 3) and obliquely truncate, external margin



Figs. 1-7. Anisosticta terminassianae, sp. n.: 1) holotype; 2) allotype; 3 and 4) male genitalia; 5) apex of siphon; 6) 6th abdominal sternite of female; 7) receptaculum seminis. Figures 3-5) holotype, Figures 6 and 7) allotype.

sloping from end of basal third. Inner margin slightly concave. Apex rounded. Several very small hairs on external margin nearer to apex than base. Parameres slightly concave on side facing penis; hairs on them sparse and short. Basal part broader than long in lateral aspect (Fig. 3). Penis (Fig. 4) in ventral aspect tapering from two thirds of its length to apex, which is broadly rounded.

Allotype, female. Almost identical with holotype, but differing in body size and elytral spots, which are more uniform in size (Fig. 2). Coloration of ventral side of body as in holotype, apart from central part of fore-margin of metasternum, which is white. Abdominal sternites paler than in holotype; brownish black color on first three sternites does not occupy the whole length of the sternite, as in the holotype, and on the 2nd and 3rd sternites it occupies only half the length. The last abdominal sternite is slightly emarginate for half width of hind-margin (Fig. 6). The inner side of this sternite with the membrane reflexed inward in the form of an inverted U. Genital plates pyriform; receptaculum seminis illustrated in Fig. 7. Body dimensions: length 4.5 mm, width 2 mm.

All the paratypes are of almost the same color; there are slight variations in the sizes of the spots on the elytra, there being a greater tendency to reduction of spots than to their increase in size. In the three specimens from China the spots on the elytra are very small. In A. terminassianae, sp. n. I found no trace of coalescence of the spots either on the pronotum or on the elytra, as is observed in A. bitriangularis Say. Sexual differences are manifested only in the slightly larger dimensions of the females. The ventral side of the body in the females is a little paler than in males, in contrast to what is observed in A. sibirica Biel.

Holotype: L. Barun-Torei, mouth of R. Ul'dza in Transbaikal, 29 VI 1925 (Vinogradov). Allotype: from the same locality as the holotype. Paratypes: 32 specimens from the same locality as holotype; 3 specimens from China, Kansu, VIII 1872 (N. M. Przewalski).

The species is named after M. E. Ter-Minasyan, of the Coleoptera Division of the Zoological Institute, AN SSSR, to whom I am very grateful for help in the examination of the collection.

In external appearance Anisosticta terminassianae, sp. n. most resembles A. kobensis Lew., but differs from all known species of the genus in the very distinctive outlines of the body. In the structure of the male

genitalia and the shape of the last sternite of the female, it is very reminiscent of A. bitriangularis (Say) and A. strigata (Thumb.).

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A REVIEW OF SPECIES OF THE GENUS TERATOLYTTA (COLEOPTERA, MELOIDAE) FOUND IN THE USSR, AND A DESCRIPTION OF TWO NEW FORMS FROM TADZHIKISTAN

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The genus Teratolytta Sem. is closely related to the very large, almost cosmopolitan genus Lytta, and was separated on the basis of the marked sexual dimorphism in the structure of the legs and usually the mesothorax in the males (Semenov, 1894: 533).

Teratolytta is restricted in its distribution to the eastern Mediterranean and Central Asia. At present we know of 9 species of this genus, the majority of them with restricted ranges, including 3 within the USSR (T. optabilis Fald. from eastern Transcaucasia, T. eylandti Sem. from Kopet-Dag and T. pilosella Sols. from Uzbekistan and Tadzhikistan), 2 from the southern and western areas of Asia Minor (one of them also occurs on islands in the Aegean Sea), 1 from Israel and probably Syria, 2 from Afghanistan, and the last – T. dives Brullé (genotype) – in contrast to the rest, is widely distributed – from Yugoslavia through Albania, Bulgaria, Greece and Asia Minor to Persia. Escherich (1894) recorded the last species for Turkmenia (Ashkhabad) also, from Rozen's collections; this record has not been confirmed since, but in view of the fact that T. dives is very common in Persia, close to the borders of the USSR (Gurgan), its presence on our territory seems quite possible.

In Borchmann's catalog (1915) the inadequately described Lytta togata Fisch.-W. (Fischer de Waldheim, 1844) was referred to this genus, but in fact it should probably be assigned to the genus Lytta, and to the species known under the name of L. flavovitta Ball., 1878, and Fischer-Waldheim's name certainly has priority.

The biology of Teratolytta species has hardly been studied at all, and nothing is known of their development. The imagos are found in spring, usually on trees; T. pilosella Sols. has been noted as a fairly serious pest of fruit trees (plum, pear, apple, almond), on which it gnaws the flower buds (Injurious Animals of Central Asia, 1949: 1041; Semenov, 1951: 384; Forest Pests, 1955: No. 2705).

Recently the well-known Hungarian entomologist Z. Kaszab (1958) reviewed the known species of Teratolytta and considerably facilitated the determination of these beetles. In an examination of Tadzhikistan material preserved in the Zoological Institute, AN SSSR, a hitherto undescribed species of this genus was discovered. Besides this, it was found that specimens of T. pilosella Sols. from the southern slopes of Gissar Range differed appreciably from the nominal form described from the Tashkent District, and ought to be separated as a quite distinct subspecies. Descriptions of these forms are given below.

The following key may be used for the identification of Teratolytta species dwelling within the USSR or recorded from our territory:

1 (2). Legs entirely dark, femora and venter metallic green, tibiae, tarsi and trochanters brownish black. The entire dorsum matt green. Head and pronotum finely punctered, densely shagreened between punctures; elytra finely shagreened and rugose. Metasternum in ♂ with two tubercles bearing brushes of long hairs; fore and midtarsi with 2 apical spurs; trochanters of hind legs with a tooth at base. 10-17 mm. Eastern Transcaucasia: Azerbaidzhan, eastern Georgia (to Tbilisi), south Dagestan (Derbent). . . . . T. optabilis Fald.

2 (1). Legs entirely or mostly rufous yellow; dorsum always shining.

3 (6). Metasternum in ♂ with two tubercles behind the mid coxae, these tubercles bearing brushes of dense, long hairs. Mid-and hind tibiae in both sexes with two apical spurs, and midtibiae in the ♂ strongly modified at apex, the inner side with an expansion or tooth bearing one of the spurs.

4 (5). Hind trochanter of ♂ with no flat or tooth-like expansion at base; tubercles on metasternum of ♂ low, elongate-oval; underside of midtibiae of male obliquely truncate when viewed from outside, without sharp angle or tooth, obliquely expanded on inner side, flat on upper side, with a rather distinct keel on outside; body uniform green, blue-green or blue, legs yellowish red, tibiae slightly darkened. 8-15 mm. Turkmenia: Kopet-Dag (Ai-Dere — loc. class., Kara-Kala and its environs); northeast Persia (Bujnurd in Turkmeno Khurasan hills) . . . . . T. eylandti Sem.

5 (4). Base of hind trochanter in ♂ with a long, broad, distally rounded process bearing a pencil of hairs on inner side. Tubercles on metasternum of ♂ short and high, with a narrow bunch of long hairs. Midtibiae strongly excised on underside, on outside with a stout, sharp apical tooth, which is pilose at tip; with a long narrow process on inner side; their upper surface not completely flattened. Body uniformly green, legs yellow (f. typ.), or each elytron with a broad copper-red longitudinal stripe in middle (ab. phalerata Friv.), or these stripes are so broad that only narrow green margins remain; suture and base of pronotum blue; head, pronotal disk and venter with golden luster (ab. excellens Escher.) or dorsum entirely purplish red, only center of pronotum, suture, lateral margins of elytra and narrow stripe in middle of elytra golden green. 10-22 mm. From Yugoslavia through the Balkan peninsula and Asia Minor to Iran; recorded from Turkmenia. The specimens from Persia (Gurgan) all belong to ab. phalerata . . . . . T. dives Brullé.

6 (3). Metasternum of ♂ simple, without tubercles bearing hair pencils. Midtibiae of ♂ with no teeth at apex.

7 (8). Fore and midtibiae of ♂ with only one apical spur (this includes T. kulzeri Kasz. from the south of Asia Minor, T. klapperichi Kasz. and T. regina Kasz. from Afghanistan).

8 (7). Fore and midtibiae of ♂ with two apical spurs.

9 (12). Apices of femora broadly darkened, bases of tibiae rather more narrowly so; tarsi dark; palps black. Vertex of ♂ usually with a broad, transverse impression interrupted in center. Body bronze, copper-green or violet-black. Fore tibiae of ♂ strongly expanded toward apex, midtibiae simple. 8-16 mm. Central Asia . . . . . T. pilosella Sols.

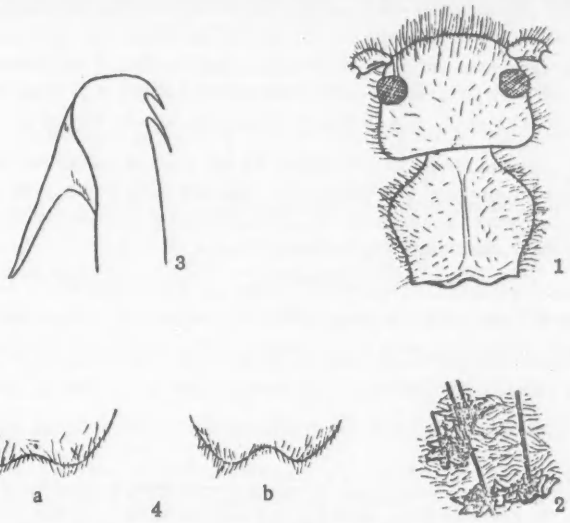
10 (11). Dorsum bronze, rarely bronze-green; elytra with even, dense, white pilosity (f. typ.) or pilosity in patches (ab. albovillosa Escher.); hind trochanters of ♂ entirely eyllow or very slightly darkened on outer margin; apical angles of last sternite of ♂ strongly rounded (Fig. 4a). Uzbekistan: Tashkent and environs, Fergana valley (Namangan); the record for "Zakaspiiskoi region" requires confirmation . . . . . T. pilosella pilosella Sols.

11 (10). Dorsum dark bronze, violet-bronze or violet-black; pilosity of elytra usually distinctly sparser; hind trochanters of ♂ heavily darkened on outer margin; apical angles of last sternite of ♂ very sharp (Fig. 4b) — Tadzhikistan: southern slopes of Gissar Range to north of Stalinabad . . . . . T. pilosella tadzhika O. Kryzhanovskij, subsp. n.

12 (9). Trochanters, femora, tibiae, tarsi and maxillary palps rufous yellow, the last with darkened apex. Head of ♂ without transverse impression on vertex or on temples. Body copper-red or purplish red, elytral suture narrowly blue, passing laterally into green and copper-red; lateral margins of elytra, median line of pronotum and its base metallic green. Fore and midtibiae of ♂ not expanded at apex. 9.5-20 mm. Tadzhikistan: southern slopes of Gissar Range (Varzob valley), Tovil'-Dara . . . . . T. kaszabi O. Kryzhanovskij, sp. n.

Teratolytta kaszabi O. Kryzhanovskii, sp. n.

Body copper-red, shining, disk of elytra and pronotum frequently purplish red, elytral suture narrowly blue, passing laterally into blue-green, green and copper; lateral margins of elytra, median line of pronotum and its base metallic green; legs (except coxae) and maxillary palps yellow, the last with a blackened apex; antennae black, three basal segments of antennae shining, remainder matt. Head, trapeziform, no impressions on temples



Figs. 1-4. 1) Teratolytta kaszabi, sp. n., ♂, outline of head and pronotum; 2) Teratolytta kaszabi, sp. n., sculpture of disk of pronotum (highly magnified); 3) Teratolytta kaszabi, sp. n., ♂, apex of genitalia; 4) Teratolytta pilosella pilosella Sols., ♂ (a), T. pilosella tadzhika, subsp. n., ♂ (b), outline of apex of last sternite.

behind eyes in ♂ or ♀; occiput with slight median impression; dorsum densely, finely and irregularly rugose and with large deep punctures, the distance between which is equal to 1.5-3 puncture-diameters; punctures bear erect black hairs; clypeus, mouth parts, 1st antennal segment and venter of head with an admixture of white hairs. Antennae fairly long and slender, in both sexes extending beyond base of elytra, their 1st-3rd segments hairy, the rest bare; in ♂ the 4th and 5th segments are stoutest, approximately 1.8 times longer than broad; 6th somewhat more slender, twice as long as broad; 7th-10th gradually tapering and of almost equal length, a little longer than 6th; 9th and 10th 2.5 times longer than broad; 11th $^1/_3$ longer than 10th and pointed at end; in ♀ the antennal segments have the same relative lengths as in ♂, but are more slender, the 9th and 10th segments 3 times as long as broad. Pronotum (Fig. 1) in both sexes a little narrower than head and very slightly broader than long; its greatest width anterad of middle; narrowing strongly anterad, less so posterad; disk convex, median line strongly impressed; base with margin turned up and hence appearing depressed; dorsum finely and densely rugose and with even larger and deeper punctures than on head; punctures bearing long erect black hairs (Fig. 2). Scutellum small, semicircular, covered with white hairs. Elytra 2.5 times as long as their total breadth, parallel-sided, with roundly projecting shoulders and separately rounded apices; their surface coarsely shagreened and covered with scattered, rather long, erect hairs, black on disk and paler on sides; lateral and apical margins with dense white hairs. Venter shining, very delicately shagreened and rugose, and with fairly dense rasp-like punctures bearing pale hairs; episterna of mesothorax and metathorax and sides of abdominal sternites with an admixture of fine dark hairs. Metasternum of ♂ without tubercles. Last sternite with large deep punctures and dark hairs, with a deep triangular excavation at apex in ♂, pointed in ♀. Legs with white hairs, longer and shaggier on femora, short and oblique on tibiae. Legs in ♀ simple. Fore and midtibiae of ♂ with two apical spurs each; fore tibiae weakly bent before apex, dorsally with roundly emarginate edge at apex; midtibiae simple; segments of fore and midtibiae without processes, pilose below, 1st segment a little broader than remainder. Penis with a small hook on dorsal side at extreme apex and immediately behind it there is a second, longer hook; both hooks point toward base; ductus ejaculatorious with very large straight hook (Fig. 3). Length (with head straightened out) 9.5-20 mm.

In coloration, general aspect and pilosity it is very similar to Teratolytta regina Kaszab from east Afghanistan (Kaszab, 1958 : 250, 255), but differs distinctly from Kaszab's description in the sculpture of the head and pronotum, the rugosity of which is very fine, and the puncturation large and deep, in the deep median, green-colored, impression on the pronotum, in the absence of an impression on the temples in the ♂, in the

presence of two apical spurs on the fore and midtibiae of the ♂, the more slender antennae and the genital structure of the ♂.

From the other species of the genus it is distinguished by the coloration and from the somewhat similarly colored T. dives Brullé, by the absence on the metasternum of the ♂ of tubercles bearing brushes of hairs, by the quite different structure of the legs in the ♂, by the sculpture of the head and pronotum.

Tadzhikistan: Kvak in the R. Varzob valley, 35 km north of Stalinabad, 2000 m 22 V 1939, V. Gussakovskii (holotype ♂, allotype ♀, 9 paratypes); Kondara in R. Varzob valley, 1100 m, 10, 20 and 22 V 1939, V. Gussakovskii (6 paratypes); Kondara, 27 IV 1951, Brodnikova (1 paratype); Tovil'-Dara in southeast Tadzhikistan 17 VI 1897, Kaznakov (2 paratypes).

The weakly developed sexual dimorphism makes the assignment of this species to the genus Teratolytta rather debatable, but in coloration, sculpture, pilosity, antennal structure, male genitalia and other characters it is so close to T. regina Kasz. and partly to T. pilosella Sols. that it must certainly be included in this genus.

The species is named after the Hungarian entomologist Dr. Z. Kaszab, the very distinguished authority on the world Meloidae.

Teratolytta pilosella tadzhika O. Kryzhanovskii, subsp. n.

It differs from the nominal form dwelling in Tashkent district by the darker, dark bronze, violet-bronze or violet-black coloration of the dorsum; venter dark copper-red. Hind trochanters of ♂ heavily darkened distally on outer margin. Last abdominal sternite of ♂ with slightly more pointed apical angles (Fig. 4a,b). Pale pilosity of dorsum usually appreciably less dense than in nominal form.

Tadzhikistan: south slopes of Gissar Range, Kondara in Varzob valley, 1100 m, 10-29 V 1939, V. Gussakovskii (holotype ♂, allotype ♀ and 4 paratypes); same locality, 4 V 1940, A. E. Semenov (15 paratypes).

SUMMARY

Three species of the east-Mediterranean genus Teratolytta were previously known in the fauna of the USSR., viz. T. optabilis Fald. from eastern Transcaucasia, T. eylandti Sem. from the Kopet-Dag Mts. and T. pilosella Sols. from Uzbekistan and Tadzhikistan. The record of T. dives Brullé, mentioned for Turkmenistan (Escherich, 1894), is doubtful; Lytta togata Fisch.-W., 1844, attributed to Teratolytta by Borchmann (1915) is probably a true Lytta and appears to be the same species as L. flavovittata Ball., 1878.

There are two new forms of this genus from Tadzhikistan in the collections of the Zoological Institute, AN SSSR in Leningrad.

Teratolytta kaszabi O. Kryzhanovskii, sp. nov.

Closely related to T. regina Kaszab, 1958 from Afghanistan and similar to it in coloration and pilosity, but differing in the sculpture of the head and pronotum (Fig. 2), the rugosity being more fine, and the punctures coarse and deep. The median suture of the pronotum is green. The male head without impressions behind the eyes. The fore and middle tibiae with two apical spurs. The antennae thinner and the male genitalia of different structure (Fig. 3). L. 9.5-20 mm.

From the other species of Teratolytta it differs in coloration and from T. dives by the absence of the brushes of hairs on the male metasternum, by the simple legs of the male and by the sculpture of the head and pronotum.

Tadzhikistan: Kvak and Kondara in Varzob valley on the southern slope of the Gissar Range; Tovil'-Dara in southeastern Tadzhikistan. Holotype male and allotype female from Kvak; 18 paratypes.

Teratolytta pilosella tadzhika O. Kryzhanovskii, subsp. nov.

Very similar to T. pilosella pilosella Sols. from Tashkent, but the upper surface darker: dark-bronze, bronze-violet or violet-black. The apical part of the hind trochanters in male mostly darkened. The apical angles of the last ventral sternite in male slightly more acute (Fig. 4b). The pilosity of the upper surface on the average more sparse.

Tadzhikistan: Kondara in Varzob valley on the southern slope of the Gissar range. Holotype male, allotype, female and 19 paratypes taken in May 1939 and 1940 by V. Gussakovskii and A. E. Semenov.

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NEW SPECIES OF SCARABAEIDAE (COLEOPTERA) FROM TADZHIKISTAN

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This paper gives descriptions of 8 new species of Scarabaeidae collected by I. K. Lopatin, mainly in southern Tadzhikistan. The types of the newly described species are preserved in the collection of the Zoological Institute, AN SSSR, in Leningrad.

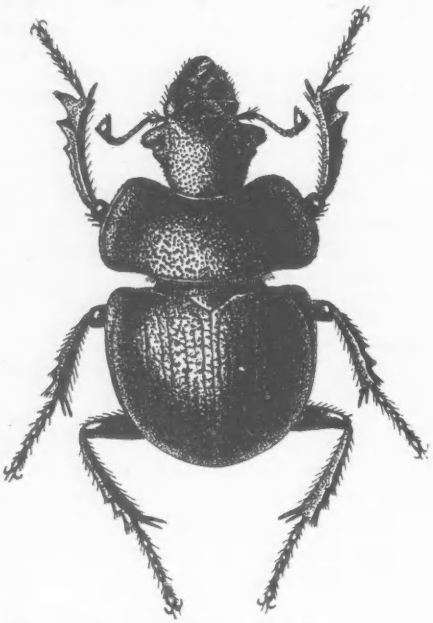


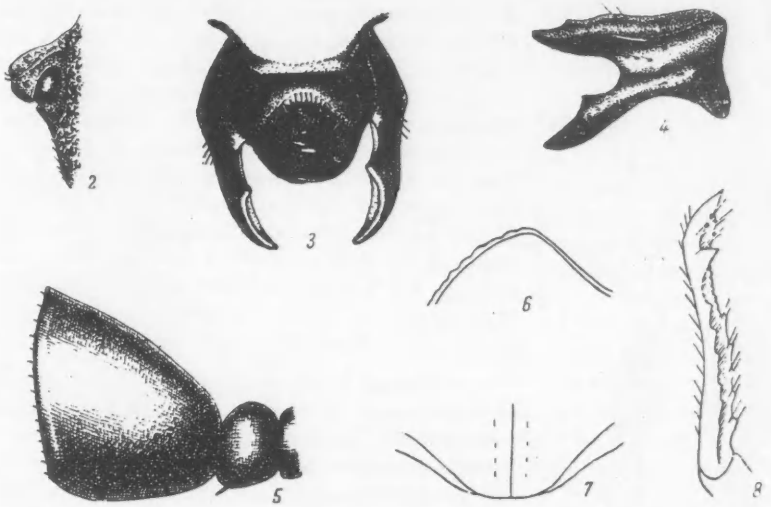
Fig. 1. Lethrus rugulosus, sp. n.

1. Lethrus (Autolethrus) rugulosus, sp. n. (Fig. 1)

Body convex, weakly shining, black, without metallic luster. Head fairly small and not very elongate, the whole head, including clypeus, almost evenly covered with very dense, large punctures, coalescing to form wrinkles, the interspaces in some parts having the form of narrow ridges; the occiput not divided by a ridge at front. The sides of the head in the region of the eyes are divided by the straight weak, very flat carina; barely visible oblique carinae extending back and inward from outer angles of clypeus. Clypeus trapeziform, slightly convex at front, without sharp edging on margins. Ocular lobes (Fig. 2) not very prominent, with convex fore margin, broadly rounded fore angles, with a small indentation on lateral margin, and invested with dense, coalescent, rugose punctures. Postorbital tooth small, weakly developed. Throat normal, convex, shining, black, red or yellow. Labrum (Fig. 3) bilobed, approximately symmetrical.

Mandibles of ♂ not protruding forward much and developed only a little stronger than in ♀, almost symmetrical, broad, with rounded lateral margins, left mandible with a small tubercle before apex; their lateral surface not bearing a sharp longitudinal ridge in center, and fairly expanded at base (more so in ♂ than in ♀). The appendages of the mandibles in the ♂ arise from almost the center of the underside of the latter, both being of roughly the same length and structure, short (shorter than mandible), directed forward and slightly downward (Fig. 4), but with the apices incurved (Fig. 3); their upper edge forms a ridge with a blunt-angled broad tooth projecting at the center; outer surface slightly convex, with longitudinal rugosity, inner side flat and smooth. Club of antennae (Fig. 5) rather short, 1st segment with slightly convex foremargin.

Pronotum almost as broad as base of elytra, with rimmed margins, having its greatest width near base, with blunt, broadly rounded fore angles, produced forward a little (Fig. 6), weakly reflexed, arcuate, with a finely crenulate lateral margin, with blunt, rounded, but quite distinct hind angles and 2 broad weak indentations



Figs. 2-8. Lethrus rugulosus, sp. n., details of structure: 2) ocular lobe; 3) mandibles ♂, frontal aspect; 4) left mandible ♂, lateral aspect; 5) club of antenna; 6) fore angle of pronotum; 7) apex of elytra; 8) foretibia ♂, lateral aspect.

on the sides of the hindmargin, and covered with very coarse, large deep punctures coalescing into wrinkles, the interspaces between the punctures smaller than the latter and some having the form of narrow convex ridges, with no noticeable concentration on median line. Scutellum with fairly numerous small punctures.

Elytra finely shagreened, narrowly reflexed at sides, rounded together at apex and cut off almost straight (Fig. 7). Epipleura demarcated by a sharp ridge along entire length of inner margin and clearly failing to reach sutural angle. Their surface appears matt, covered with fairly dense, pit-like, somewhat effaced punctures, transverse and oblique wrinkles, rather uneven; elytral striae shallow, not very distinct, divided by unequal, but not paired, intervals. Venter of body with dense puncturation, sides of prothorax with fine longitudinal wrinkles.

Fore femora without tooth or projection on foremargin. Foretibiae with 5 sharp teeth on underside, and with a series of small tubercles in fore third (Fig. 8). External genital armature of ♂ in Figs. 9, 10 and 11. Body length ♂ 16.8 mm, width of pronotum and elytra 9.6 mm, length of mandibular appendages 1.8 mm, body length ♀ 16.9 mm, width 9.8 mm.

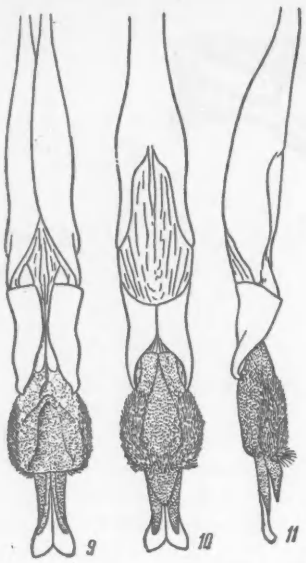
Distribution. Tadzhik SSR: Kondara, Kvak, at height 1700 m above sea-level, 24 VI 1955, 1 ♂ and 1 ♀; Gissar Range, 18 km north of Stalinabad, at height 1400 m, 8 V 1957, 1 ♂ (I. K. Lopatin).

Material used. 2 ♂♂ and 1 ♀ in collection of Zoological Institute, AN SSSR, in Leningrad.

Taxonomic notes. From the structure of the mandibles, mandibular appendages and fore femora in ♂, and also the fore angles of the pronotum, this species belongs to the subgenus Autolethrus Sem. The presence of short mandibular appendages, shorter than the mandibles, brings this species close to L. eous Sem. and L. hauseri Reitt., but the teeth on the fore ridge of the appendages are almost equally well developed on both mandibles and are situated in the center of the fore ridge and not in the apical part. The puncturation of the pronotum is very dense, as in L. hauseri, but with no concentration along the median line. The elytral sculpture also differs from that in these two species.

2. Lethrus (Heteroplistodus) tadzhikorum, sp. n. (Fig. 12)

Body convex, dully shining, black, without metallic luster. Head in ♂ large (in ♀ somewhat smaller), with dense, rather coarse, microscopic puncturation and with dense small, partly rugose punctures, somewhat sparser and large punctures in hind part; occiput with very fine dense punctures, not separated from vertex by a ridge. Sides of head in region of eyes divided by indistinct almost straight, rugose carinae. Oblique carinae extending



Figs. 9-11. Lethrus rugulosus, sp. n., external genital armature ♂: 9) dorsal aspect; 10) ventral aspect; 11) lateral aspect.

back and inward from outer angles of clypeus weakly developed, flat. Clypeus trapeziform, with weakly convex foremargin and rounded fore angles, without raised rim on margins, and covered with dense small punctures (as on fore part of frons). Ocular lobes (Fig. 13) short, weakly prominent laterally, with convex foremargin, broadly rounded fore angles, covered with flat rugose punctures. Throat normally convex, smooth, black. Labrum (Fig. 14) bilobed, symmetrical. Mandibles of ♂ (Fig. 14) large, rather broad, with moderately rounded outer angles, and slightly asymmetrical (left a little narrower and slightly shorter than right), without preapical tubercles. Their lateral surface in ♂ strongly expanded in basal part, without longitudinal ridge; in ♀ it is much less dilated and tapers gradually to the ends of the mandibles. Mandibular appendages of ♂ (Fig. 14) unequal; appendage of left mandible much longer than that of right.

Appendage of left mandible (Fig. 15) arises from basal half, extends downward and forward , and at apex turns almost straight forward, weakly sigmoid and, in frontal aspect, incurved at apex, laterally compressed, with a strong ridge on fore-and hindmargins, and from near the end of basal third of foremargin there arises a strong rounded projection, broadly, or frequently rather narrowly, rounded at apex; its outer surface slightly convex, inner concave, in well-developed individuals with a longitudinal convexity not reaching apex. Right mandibular appendage (Fig. 16) much shorter, directed forward and slightly downward , gradually tapering to apex, in frontal aspect (Fig. 14) bent slightly inward in center, incurved at apex; its outer surface convex, inner flat, with a more or less developed knob in well-developed individuals. Club of antennae (Fig. 17) rather elongate, 1st segment with almost straight fore margin.

Pronotum markedly transverse, appreciably broader than base of elytra, with somewhat flattened lateral margins, its greatest width in hind third, with blunt rounded fore angles produced forward slightly (Fig. 18), almost smooth, finely sinuate, rounded lateral margin, with greatest convexity in last third, broadly rounded, distinct hind angles and almost imperceptible broad indentations on sides of hindmargin, covered with very fine puncturation and dense, deep, rather coarse punctures (as on vertex), which in places merge together into short series extending in various directions, and without a dense strip in center. Scutellum with shallow, sparse punctures at base.

Elytra semicircular, convex, rounded together at apex in ♂ (Fig. 19), but in ♀ (Fig. 20) produced into a short broad projection. Epipleura demarcated on inner margin by a sharp ridge and at the end stopping just short of the sutural angle; lateral margins flattened slightly in fore third. Striae shallow, paired, the intervals between them almost flat, the 1st, 3rd and 5th much narrower than 2nd, 6th and 7th; the last is very short,and outside of it the striae are indistinct. Surface of elytra covered with dense, very fine puncturation and sparse, large (larger than on pronotum) flat punctures, and also numerous, fairly distinct transverse and oblique wrinkles.

Venter with dense shallow rugose punctures, sides of prothorax with very fine longitudinal wrinkles, coxae with dense, fine punctures. Fore femora in both sexes lacking tooth or projection at front. Foretibiae (Fig. 21) with numerous (up to 7-8) sharp teeth on underside. External genital armature on ♂ in Figs. 22, 23 and 24. Body length ♂ 22.7-24.8 mm, width of pronotum 12-12.8 mm, width of elytra 11-11.8 mm, length of left mandibular appendage 3.6-5.8 mm, length of right appendage 2.0-3.7 mm, body length ♀ 19-20 mm, width of pronotum and elytra 11-12 mm.

Distribution. Tadzhik SSR, Kulyab Region, Kangurt District, southern spur of Vakhsh Range, Pushta-Mazor Range, Safed-Doron, 14-15 IV, 21 IV 1954. Beetles collected at height 1800 m (L. K. Lopatin).

Material used. Six ♂♂ and 4 ♀♀ in the collection of the Zoological Institute in Leningrad.

Taxonomic notes. This new species, belonging to the subgenus Heteroplistodus, is closer to L. furcatus Jak.

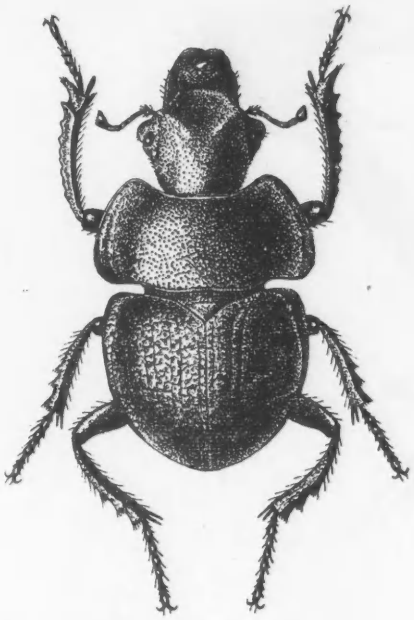


Fig. 12. Lethrus tadzhikorum, sp. n.

than to other representatives of this subgenus, but is distinguished from it by the different structure of the mandibular appendages of the male, the weak striae on the elytra and other characters.

3. Lethrus (Heteroplistodus) inconspicuus, sp. n. (Fig. 25)

Body convex, weakly shining, black, with a weak bronze sheen. Head large, almost uniformly covered with dense large deep punctures, some coalescing to form wrinkles, a little sparser on hind part of vertex; occiput with dense shallow punctures, not marked off by a ridge at front. Sides of head in region of eyes divided by indistinct, straight, rugose carinae. Oblique carinae extending forward and inward from outer angles of clypeus barely visible. Clypeus trapeziform, with slightly convex fore margin, covered with dense large (as on front part of frons) rugose punctures. Ocular lobes (Fig. 26) very short, weakly protruding laterally, with very slightly convex fore margin and moderately rounded fore angles, densely and rugosely punctured. Postorbital tooth small. Throat normally convex, smooth, shining, red. Labrum (Fig. 27) bilobed, roughly symmetrical.

Mandibles of ♂ (Fig. 27) rather large, of equal lengths, with rounded outer angles, the apex of the right mandible turning in more sharply than that of left. Their lateral surface greatly expanded in basal half, with no longitudinal ridge in center. Mandibular appendages of ♂ not highly developed, rather short, unequal: left mandibular appendage a little, but distinctly, longer than right. Both appendages simple, without teeth, rather slender, gradually tapering toward apex, arising at a third of distance from base of mandibles, and pointing forward and slightly downward (Figs. 28, 29), but with the apices curving inward (Fig. 27), with no appreciable bend in center. Club of antennae (Fig. 30) moderately elongate, the foremargin of 1st segment being slightly concave in center.

Pronotum distinctly transverse, with rimmed margins, noticeably broader than base of elytra, and with greatest width not far from base, with slightly blunt, broadly rounded fore angles slightly produced forward (Fig. 31), arcuate convex, with very finely and barely perceptibly sinuate lateral margins, with blunt, broadly rounded, barely perceptible hind angles and two very weak, broad emarginations on sides of hindmargin, and covered with dense large deep punctures, some fusing into rows extending in various directions, with an indistinct denser longitudinal strip in center; on the sides the punctures are denser and rugose.

Elytra short, semicircular, convex, jointly blunted at apex and almost straight (Fig. 32), narrowly reflexed laterally in fore part. Epipleura demarcated by a sharp ridge over whole length of inner margin and stopping a little short of sutural angle. Surface of elytra covered with rather dense large shallow, flat, often coalescent punctures and fine transverse and oblique wrinkles, and appearing uneven; striae weak, indistinct, the intervals between them flat, of approximately equal width, striae completely fading out at sides.

Venter with dense fine punctures, sides of prothorax with fine longitudinal wrinkles, coxae with dense fine punctures. Fore femora without tooth or projection at front. Underside of foretibiae (Fig. 33) with a series of teeth, the first 4 from the base being stouter and sharp, the rest having the form of tubercles. Body length ♂ 18 mm, width of pronotum 10.6 mm, width of elytra 10 mm, length of right mandibular appendage 2.0 mm, length of left mandibular appendage 2.7 mm. ♀ unknown.

Distribution. Tadzhik SSR, Khozrati-Sho Range, Sarkoron, height 1700 m above sea level, 29 V 1957 (I. K. Lopatin).

Material used. 1 ♂ in collection of Zoological Institute, AN SSSR, in Leningrad.

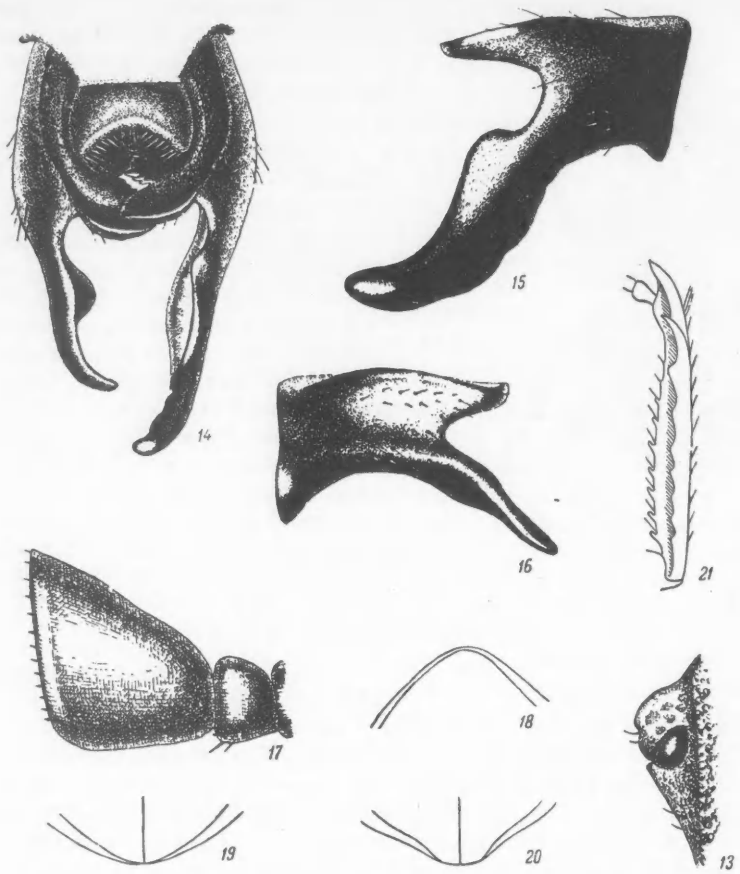
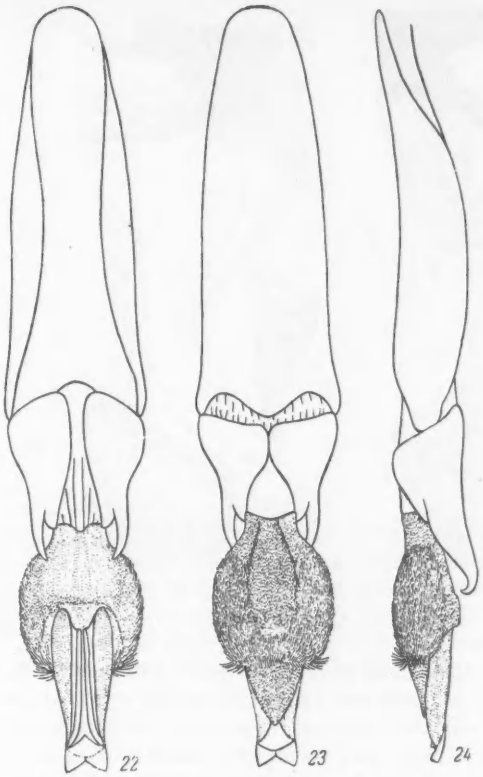


Fig. 13-21. Lethrus tadzhikorum, sp. n., details of structure: 13) ocular lobe; 14) mandibles ♂, frontal aspect; 15) left mandible ♂, lateral aspect; 16) right mandible ♂, lateral aspect; 17) club; 18) fore angle of pronotum; 19) apex of elytra ♂; 20) apex of elytra ♀; 21) foretibiae ♂, lateral aspect.

Taxonomic notes. This species belongs to the subgenus Heteroplistodus Sem. and comes closest to L. furcatus Jak., from which it differs in the much poorer development, and different form of the mandibular appendages in the ♂, the symmetrical labrum, the convex foremargin of the clypeus and the rather more elongate club. It differs from L. tadzhikorum, sp. n., in the smaller size, structure of mandibular appendages in ♂, structure of fore tibiae and other characters.

4. Lethrus (Heteroplistodus) lopatini, sp. n. (Fig. 34)

Body convex, shining, black, without metallic luster. Head large, matt, very finely shagreened, with rather sparse and fine puncturation, sparser in center of frons and on vertex, and somewhat denser at sides. Sides of head in region of eyes divided by very strong sharp arcuate carinae. Oblique carinae extending back and inward from outer angles of clypeus flat, terminating (in fore part of frons) in two rather stout tubercles from which extend toward occiput two smooth, fairly distinct arcuate carinae, between which, in center of head, there is a broad longitudinal impression. Occiput separated from vertex by a sharp, centrally interrupted carina, smooth, shining, covered with occasional fine punctures. Clypeus trapeziform, with rounded fore angles and foremargin, with a fine raised edge at front, smooth, finely shagreened, with or without occasional punctures. Ocular lobes (Fig. 35) strongly protruding laterally, with an almost straight (very slightly convex) fore margin, not very rounded fore angles, broadly rounded hind angles, covered with sparse punctures. Postorbital teeth small. Throat normally



Figs. 22-24. Lethrus tadzhikorum, sp. n., external genital armature ♂: 22) dorsal aspect; 23) ventral aspect; 24) lateral aspect.

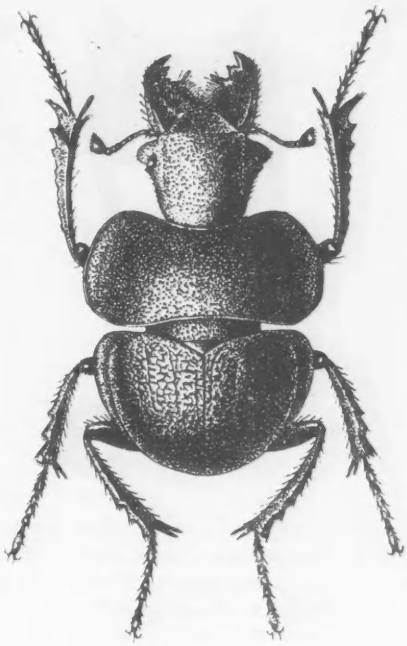


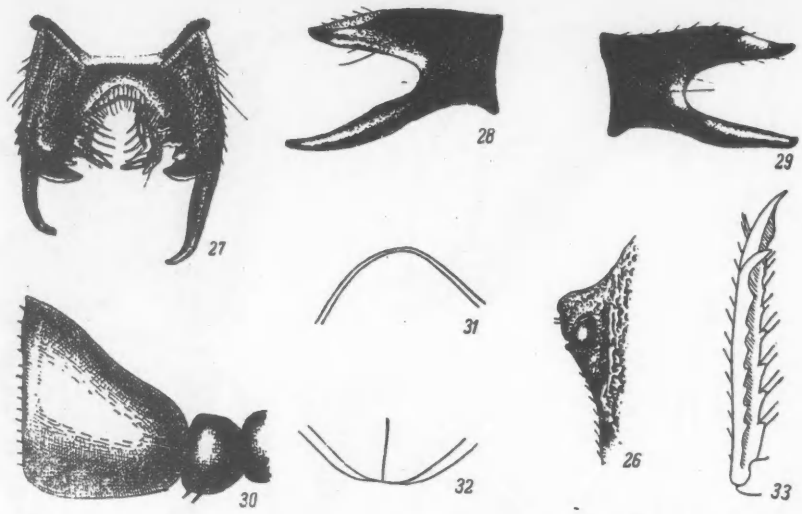
Fig. 25. Lethrus inconspicuus, sp. n.

convex, shining black. Labrum (Fig. 36) bilobed, very asymmetrical, its right lobe much longer than left.

Mandibles of ♂ large, broad, fairly asymmetrical. Left mandible shorter, with normal arcuate convex outer margin and apex pointing forward and inward, right mandible considerably larger, turned sharply and straight inward in the apical part (Fig. 36). Left mandible with lateral surface strongly expanded in basal part, without ridge in center of latter, and bearing on underside an appendage (Fig. 37) arising from base of mandible and differing little from it in length. It points downward, a little forward, and at very apex turns slightly inward otherwise straight throughout, without sharp teeth or ridges, gradually converging to apex, which is flattened, slightly expanded and cleft, terminating in two short, conical, laterally directed processes (Fig. 38). Right mandible (Fig. 39) with lateral surface greatly expanded at base, but rapidly tapering toward apex, without appendage on underside. Club (Fig. 40) elongate, 1st segment with straight fore margin.

Pronotum shining, smooth, very transverse, of same width or a little wider than base of elytra, rimmed on margins, with broadly rounded hind angles produced forward a little (Fig. 41), rather broadly reflexed, serrated finely and bluntly in fore part, with smooth margins over rest of length, broadly rounded but distinct hind angles, in front of which it has its greatest width, and with broad arcuate indentations on sides of hindmargin, very unevenly covered with large deep punctures; on sides puncturation is rather dense, rasp-like, denser near fore and hindmargins, very sparse in center of disk, on median line dense in places, but not forming a continuous longitudinal stripe. Scutellum sparsely and finely punctured.

Elytra short, convex, semicircular, rounded separately at apex (Fig. 42), forming a weak triangular notch at suture. Their lateral margins rather strongly reflexed and flattened, epipleura demarcated on inner margin by a sharp ridge, weaker in apical part and fading out there, reaching neither to suture nor to outer margin of elytra. Surface of elytra smooth, shining (with exceptionally small, dense puncturation), with solitary large punctures, moderately deep striae, divided by rather convex intervals, of which the 1st (nearest suture) is narrowest, 2nd broader than it but narrower than succeeding ones (from 3rd to 7th), which are equally broad, 8th and 9th intervales narrow.



Figs. 26-33. Lethrus inconspicuus, sp. n., details of structure: 26) ocular lobe; 27) mandibles ♂, frontal aspect; 28) left mandible ♂, lateral aspect; 29) right mandible ♂, lateral aspect; 30) club; 31) fore angle of pronotum; 32) apex of elytra; 33) foretibia ♂, lateral aspect.

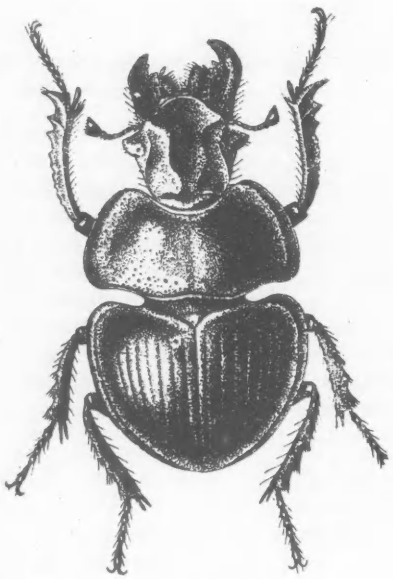


Fig. 34. Lethrus lopatini, sp. n.

Venter with dense fine rasp-like puncturation, the sides of the prothorax with longitudinal rows of very large and deep rasp-like punctures. Fore coxae punctured, with smooth stripe at front. Fore femora of ♂ without tooth or projection at front. Underside of foretibiae (Fig. 43) with 3 sharp teeth and with a few (2-3) blunt projections at base. External genital armature of ♂ in Figs. 44, 45 and 46. Body length ♂ 23.5-24.5 mm, width of pronotum 11.8-12.8 mm, width of elytra 11.5-12.8 mm, length of left mandibular appendage 4-5 mm. ♀ unknown.

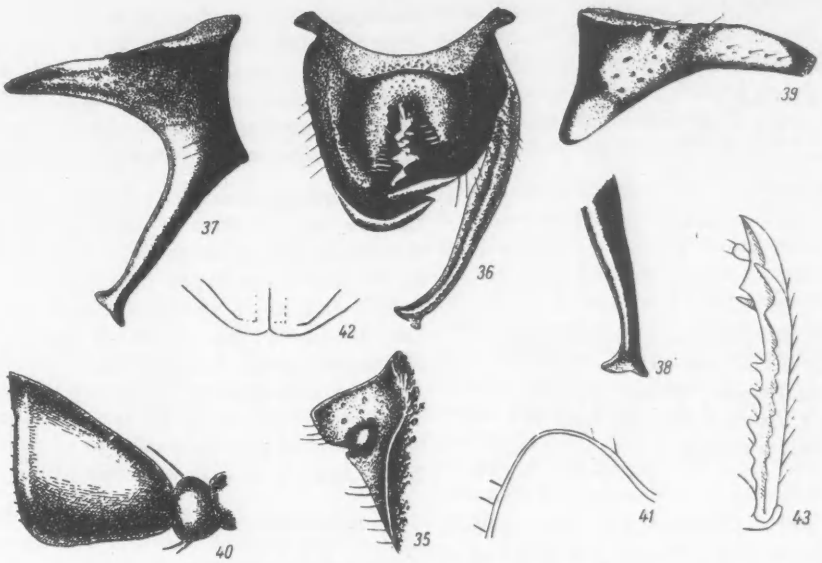
Distribution. Tadzhik SSR: foothills of Aruk-Tau Range, bank of R. Vakhsh, 5 IV 1957, 1 ♂; Shaartuz District, Chiligor-Chashma, desert, 6 IV 1957, 1 ♂ (L. K. Lopatin).

Material used. 2 ♂♂ in collection of Zoological Institute AN SSSR in Leningrad.

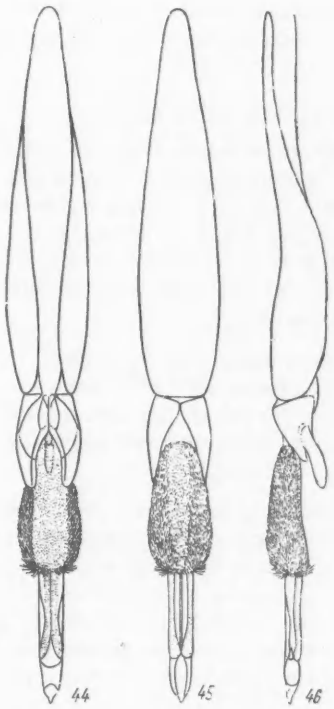
Taxonomic notes. This new representative of the subgenus Heteroplistodus Sem. is closest to L. obliquus Sem., from which it differs in the apically cleft left mandibular appendage, the puncturation of head, the structure of pronotum and the elytra.

5. Onthophagus umbilicopunctatus, sp. n. (Fig. 47)

Body broad, moderately convex. Head rather shining, finely shagreened, with two transverse carinae. Fore transverse cephalic carina in both sexes rather weak, arcuate. Hind transverse carina in ♂ (Fig. 48) produced into a short broad plate, bearing at sides two upward-pointing horns with apices curving backward (Fig. 49), and between the horns the median plate forms a blunt-angled projection in center. In ♀ (Fig. 50, 51) the hind transverse carina slightly raised and bearing at apex 3 blunt teeth (2 lateral and 1 median). Clypeus in ♂ and ♀ covered with rather dense rasp-like punctures, with a fairly deep triangular notch in front. Head invested with yellowish brown setae on margins, and with blackish brown hairs below. Club brownish black.



Figs. 35-43. Lethrus lopatini, sp. n., details of structure: 35) ocular lobe; 36) mandibles ♂, frontal aspect; 37) left mandible ♂, lateral aspect; 38) left mandibular appendage ♂; 39) right mandible ♂, lateral view; 40) club; 41) fore angle of pronotum; 42) apex of elytra; 43) foretibia ♂, lateral aspect.



Figs. 44-46. Lethrus lopatini, sp. n., external genital armature ♂: 44) dorsal aspect; 45) ventral aspect; 46) lateral aspect.

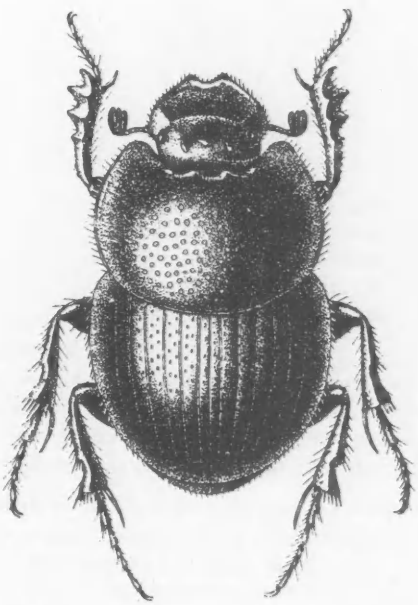
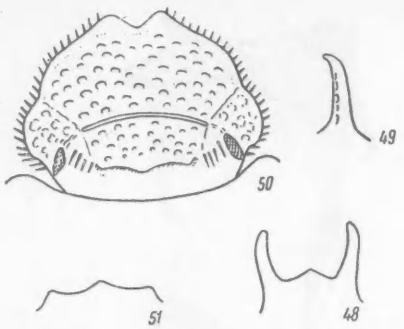
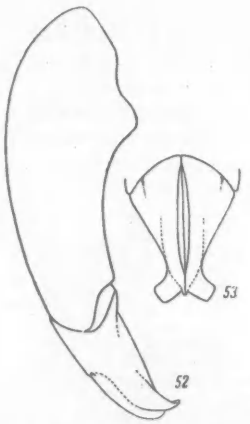


Fig. 47. Onthophagus umbilicopunctatus, sp. n.

Pronotum matt, shagreened, with simple rounded fore angles, without emarginations on sides in front of them, in ♂ at front with 4 tubercles, of



Figs. 48-51. Onthophagus umbilicopunctatus, sp. n., details of structure: 48) hind cephalic carina ♂, frontal aspect; 49) horn of cephalic carina ♂, lateral aspect; 50) head ♀; 51) hind cephalic carina ♀.



Figs. 52-53. Onthophagus umbilicopunctatus, sp. n., external genital armature ♂. 52) Lateral general aspect; 53) parameres, dorsal aspect.

which the middle 2 are rather close together and well-developed, while the other two on the outside are very weak, sometimes obsolescent; in ♀ at front with only 2 tubercles and covered with not particularly dense, rather large, umbilicate punctures, bearing rather short dark brown hairs, with rasp-like punctures only at front close to tubercles; sides bearing yellowish brown hairs.

Elytra shagreened, with fine punctate striae and flat intervals, on which there are tiny shining granules, bearing short brown hairs; these granules form 1 row on 1st interval, and 2 irregular rows on other intervals. Pygidium slightly convex, shagreened, covered with rather numerous short erect dark brown hairs. Venter and legs with sparse punctures, smooth, with sparse, long, blackish brown hairs. Metasternum smooth in center, without striae. External genital armature of ♂ in Figs. 52-53. Black, matt above, shining below, teeth on fore tibiae and tarsi with brownish tinge. Body length 5.4-5.8 mm, width 3.2-3.3 mm.

Distribution. Tadzhik SSR, Kulyab Region, Kangurt District, south spur of Vakhsh Range, Pushta-Mazor Range, Safed-Doron, height 1800 m. Beetles found in horse dung, 14-21 IV 1954 (L. K. Lopatin).

Material used. 2♂♂ and 1 ♀ in collection of Zoological Institute AN SSSR in Leningrad.

Taxonomic notes. This new species is close to O. semicornis Panz., from which it differs in the umbilicate puncturation of the pronotum, the form of the hind cephalic carina and certain other characters.

6. Pectinichelus lopatini, sp. n. (Fig. 54)

Body rather convex above, a little expanded behind, elongate; similar to P. rhizotrogoides Ball. Clypeus (Fig. 55) broad, transverse, with rounded foremargin and broadly rounded indistinct fore angles, a little narrowed at base, rather strongly elevated at front, separated from frons by an arcuate suture, and covered with dense large punctures and rather long erect rufous hairs.

Frons smooth, without rugose transverse carina, covered with very dense fine punctures and dense, long (3 times longer than on clypeus), erect rufous hairs. Occiput bare, smooth, eyes very prominent. Antennae 10-segmented, in ♂ (Fig. 56) with straight club, equal in length to footstalk, in ♀ (Fig. 57) the club is shorter than flagellum. Last segment of maxillary palps (Fig. 58) elongate, narrowing slightly apically and broadly blunt there, with small oval pit in basal part.

Pronotum a little narrower than base of elytra, moderately convex, transverse, with greatest width behind center, converging more strongly anterad than caudad, evenly covered with dense, large (as on clypeus) punctures and dense, long (much longer than on frons) erect rufous hairs. Its foremargin rimmed, the rim interrupted in center, fore angles blunt, lateral margin rimmed and finely serrate (teeth pointing upward roundly convex behind center, slightly emarginate anterad and caudad, hind angles blunt, moderately rounded, hind margin not rimmed, convex in middle, with broad emarginations on sides. A bunch of very long yellow hairs projects from under the hindmargin of the pronotum, in front of scutellum. Scutellum triangular, with rather numerous, small (smaller than on pronotum) punctures.

Elytra broadening a little caudad, elongate, with normally developed humeral tubercles, bluntish sutural

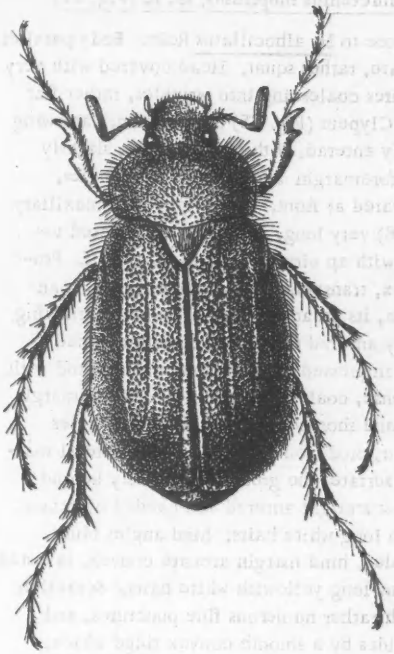
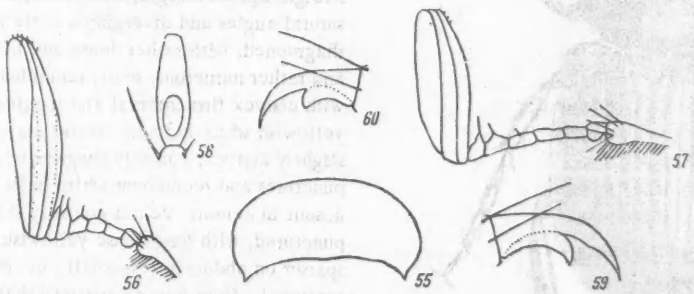


Fig. 54. Pectinichelus lopatini, sp. n.

angles, bare, covered with dense, large (larger than on pronotum) punctures, with smooth 1st interval and 4 ridges on each, of which the 2 inner ridges are more distinct, smooth, the outer ones weakly expressed. Lateral margin bearing a row of dense, yellow hairs, rather long in region of humeral tubercles, shorter over remaining extent.

Pygidium rather convex, bare, with sparse, very small punctures. Thorax with dense long yellow hairs. Abdomen with rather sparse small punctures, bearing yellow, short, recumbent, and longer (but considerably shorter than on thorax) hairs. Hind femora moderately expanded, evenly covered with rather sparse small punctures bearing long yellow hairs. Foretibiae of ♂ with 3 teeth outside, with a spur on inner margin opposite the notch between basal and median teeth. Mid-and hindtibiae as in P. rhizotrogoides Ball. Claws in (Fig. 59) weakly bent, a little more strongly so at apex, deeply cleft beyond center, the lower tooth broader and much shorter than apex of claw; lower margin of claw with very fine, blunt serration from base to just short of center. In ♀ (Fig. 60) claws not serrate on underside and their lower tooth much shorter than in ♂, and blunt at apex. External genital armature of ♂ in Figs. 61, 62 and 63.

Apart from structure of antennae and claws, the ♀ differs from ♂ in the shorter hairs on the pronotum, almost



Figs. 55-60. Pectinichelus lopatini, sp. n., details of structure: 55) clypeus; 56) antenna ♂; 57) antenna ♀; 58) last segment of maxillary palp; 59) claw ♂; 60) claw ♀.

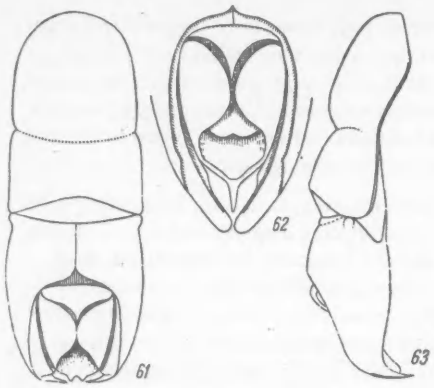
smooth pygidium, greatly expanded hind femora and apices of hind tibiae.

Shining, brownish yellow. Body length ♂ 11-13.7 mm, width of pronotum 4.2-5.2 mm, width of elytra 5.6-7.0 mm, body length ♀ 16 mm, width of pronotum 6.7 mm, width of elytra 8.0 mm.

Distribution. Tadzhikistan: southern spur of Vakhsh Range, Pushta-Mazor Range, at height 1800 m, 14 IV 1954, 2 ♂♂ and 1 ♀ caught on wing at dusk; Pam-Dara, at height 2400 m, 4 VI 1957, 1 ♂ (I. K. Lopatin).

Material used. 2 ♂♂ and 1 ♀ in collection of Zoological Institute, AN SSSR, in Leningrad.

Taxonomic notes. In structure of claws in ♂, which are serrate below, the unrimmed hindmargin of pronotum and pale coloration of body, this new species closely resembles P. rhizotrogoides Ball., but differs from it in the absence of a rugose carina on the frons, in the clypeus, which has no distinct fore angles, the even puncturation of the pronotum, and other characters.



Figs. 61-63. Pectinichelus lopatini, sp. n., external genital armature ♂: 61) dorsal aspect; 62) lateral aspect; 63) apex in hind aspect.

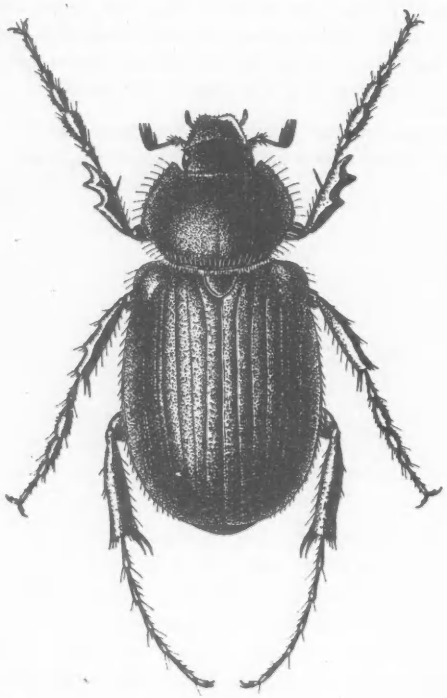


Fig. 64. Hemictenius subpilosus, sp. n.

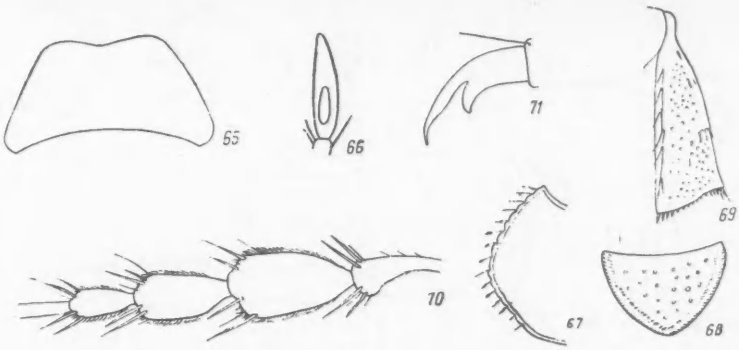
7. Hemictenius subpilosus, sp. n. (Fig. 64)

♂. Close to H. albociliatus Reitt. Body parallel-sided, elongate, rather squat. Head covered with very dense punctures coalescing into wrinkles, rather flat on clypeus. Clypeus (Fig. 65) trapeziform, narrowing fairly strongly anterad, with straight sides, slightly emarginate foremargin and rounded fore angles, strongly elevated at front. Last segment of maxillary palps (Fig. 66) very long, somewhat constricted toward apex, with an elongate pit in basal half. Pronotum convex, transverse, somewhat narrower than base of elytra, its greatest width in center, narrowing more strongly anterad than caudad, with rimmed margins and impressed median line, and covered with fine, very dense, coalescent wrinkles. Its foremargin bears sparse and short yellowish hairs, fore angles (Fig. 67) right, produced forward a little, lateral margin coarsely serrate, the greatest convexity behind center, almost straight anterad and caudad of center, invested with long white hairs; hind angles blunt, broadly rounded, hind margin arcuate convex, invested with numerous long yellowish white hairs. Scutellum (Fig. 68) with rather numerous fine punctures, and bounded at sides by a smooth convex ridge which, however, is not demarcated by a furrow.

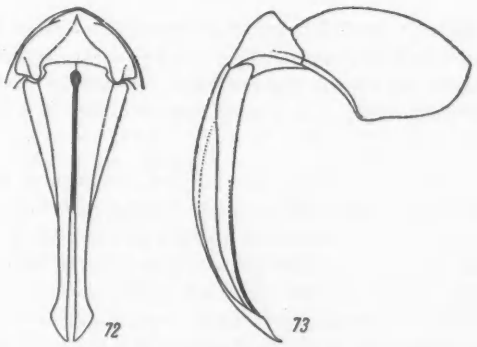
Elytra elongate, with slightly rounded sides, straight apical margin, with blunt, but not rounded, sutural angles and diverging a little to the sides there, shagreened, with rather dense and large flat punctures and rather numerous, short, recumbent whitish hairs, with convex first interval and longitudinal ridges, with yellowish white hairs on lateral margin. Pygidium slightly convex, coarsely shagreened, with fine indistinct punctures and recumbent white hairs, longer on margins, absent in center. Venter coarsely shagreened and punctured, with long dense yellowish white hairs, sparser on abdomen (especially in center), randomly scattered. Hind femora coarsely shagreened, with scattered, rather numerous, long white hairs. Foretibiae as in H. lopatini sp. n. Mid-and hindtibiae shagreened, rather shining, fairly densely punctured on outside; midtibiae rather strongly dilated, hind (Fig. 69) gradually and strongly dilated toward apex, but not bell-shaped there, with a transverse spiniferous carina slightly beyond the middle. Tarsi considerably longer than tibiae. Fore and midtarsi of ♂, as in other species, dilated, with brushes of dense hairs on underside; their 1st segment slightly dilated at apex; 2nd, 3rd and 4th 1½ times, or more than 1½ times, as long as broad (but less than twice as long) (Fig. 70). Claws (Fig. 71), as in other species of this genus, cleft, the tooth considerably shorter and broader than the apex of the claw. External genital armature of ♂ in Figs. 72 and 73. Matt, black, elytra black-reddish brown, teeth of fore tibiae and claws red. Length ♂ 10 mm, width at shoulders 4.4 mm, width behind 4.8 mm. ♀ unknown.

Distribution. South Uzbekistan, Kantugai, semidesert foothills ("adyry"), 4 IV 1954, 2 ♂♂ (L. K. Lopatin).

Material used. 2 ♂♂ in collection of Zoological Institute AN SSSR in Leningrad.



Figs. 65-71. Hemictenius subpilosus, sp. n., details of structure: 65) clypeus; 66) last segment of maxillary palp; 67) lateral margin of pronotum; 68) scutellum; 69) hindtibiae; 70) 1st-4th segments of fore tarsus ♂; 71) claw.



Figs. 72-73. Hemictenius subpilosus, sp. n., external genital armature ♂: 72) parameres, dorsal aspect; 73) general view, lateral aspect.

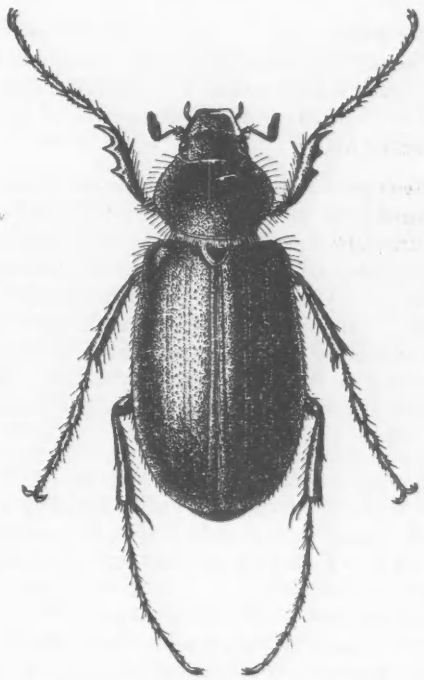
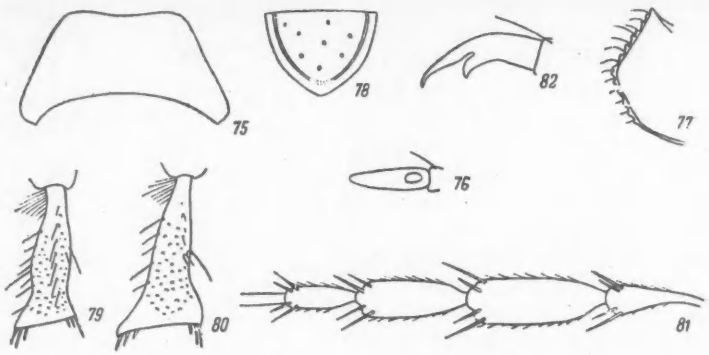


Fig. 74. Hemictenius lopatini, sp. n.

Taxonomic notes. It differs from the related H albociliatus Reitt. in the occiput being covered with dense wrinkles and matt (in H. albociliatus it is shining, with simple punctures), in the puncturation of the pronotum and the narrower 2nd-4th segments of the fore tarsi, the somewhat larger body size and the brown coloration of the elytra.

8. Hemictenius lopatini, sp. n. (Fig. 74)

Close to H. lebedevi Reitt. Body of ♂ elongate, elytra long, with weakly rounded sides, and expanding slightly caudad. In ♀ the body is broader and the sides of the elytra are strongly rounded. Head, including clypeus and occiput, covered with very dense and fine rugose punctures, the interspaces having the form of narrow ridges. Clypeus (Fig. 75) trapeziform, with straight sides, weakly emarginate foremargin and rounded fore angles, fairly strongly elevated at front. Last segment of maxillary palps (Fig. 76) elongate, tapering toward blunt apex, with a small oval pit at base. Pronotum convex, transverse, in ♂ slightly narrower, in ♀ not narrower, than base of elytra, with rimmed margins, its greatest width in center, in ♂ narrowing slightly more strongly anterad than caudad, in ♀ narrowing equally in both directions, and covered with fine, extremely dense, confused wrinkles, without distinct normal puncturation. Its fore and hindmargin lacking hairs, fore angles (Fig. 77) produced strongly forward acute, lateral margin fairly



Figs. 75-82. Hemictenius lopatini, sp. n., details of structure: 75) clypeus; 76) last segment of maxillary palp; 77) lateral margin of pronotum; 78) scutellum; 79) hindtibia ♂; 80) hindtibia ♀; 81) 1st-4th segments of fore-tarsus ♂; 82) claw.

rounded in center, almost straight anterad and caudad of center, coarsely serrate and invested with a series of rather fine yellowish hairs. Hind angles blunt, very broadly rounded, indistinct, hindmargin arcuate convex, without lateral emarginations. Scutellum (Fig. 78) shagreened, with sparse fine punctures, bordered on lateral margins by a smooth convex rim demarcated on inside by a deep furrow; in ♀ scutellum much shorter, without such a lateral rim.

Elytra in ♂ long, with weakly rounded sides, in ♀ broader, with strongly rounded sides, shagreened, with weak paired striae enclosing flat intervals covered by rather dense, weak, fine rasp-like punctures and very sparse fine whitish hairs, more conspicuous at apex. Lateral margin of elytra invested with yellowish white hairs, rather long in shoulder region and shorter elsewhere, hindmargins rounded separately and bearing a fringe of dense white hairs; sutural angles blunt, rounded. Pygidium in ♂ slightly convex, in ♀ flat, with 2 large impressions on sides, shagreened, with sparse small punctures and a few, very small, recumbent whitish hairs. Venter shagreened and covered with rather dense small punctures and fairly dense white hairs, which are scattered at random not only on the thorax but on the abdominal sternites too. Hind femora in ♂ and ♀ shining, with very fine puncturation, being evenly covered with small, rather dense punctures and long white hairs, the latter not arranged in any kind of series.

Foretibiae with 3 teeth on outside, the middle tooth just next to the apical, a spur on inner margin opposite notch between middle and basal tooth. Midtibiae expanded a little, shining, with small sparse punctures. Hind-tibiae of ♂ (Fig. 79) moderately dilated, with a preapical constriction and a moderately expanded, bell-like apex, with a very weakly developed transverse spiniferous carina in center, and covered with dense, large and small punctures on outer side; in (Fig. 80) the apical bell of the hindtibiae is more pronounced. Outer surface of hindtibiae shining, with very small punctures. Tarsi, as in other species of this genus, much longer than tibiae. In ♂ fore-and midtarsi have weakly dilated segments, bearing dense bunches of hair on underside (Fig. 81); 1st segment expanded a little in apical part, 2nd, 3rd and 4th elongate, each being more than twice as long as broad. Claws (Fig. 82) weakly bent and, as usual, cleft. Black, matt above, venter and legs shining, claws red. Length ♂ 12 mm, width at shoulders 5.0 mm, width behind 5.9 mm, length ♀ 13.7 mm, width at shoulders 5.4 mm, width behind 6.5 mm.

Distribution. Tadzhik SSR, Shaartuz district, Chiligor-Chashma, desert, 6 IV 1957, 1 ♂ and 1 ♀ (L. K. Lopatin).

Material used. 1 ♂ and ♀ in collection of Zoological Institute, AN SSSR, in Leningrad.

Taxonomic notes. This species differs from the closely related H. lebedevi Reitt. in the solid puncturation of the head, the presence of a smooth lateral rim, marked off by a furrow, on the scutellum of the ♂, the presence of hairs on the elytra, scattered hairs on the abdomen (in H. lebedevi they are arranged in rows), the form of the hindtibiae in ♂ and ♀, and also in the fact that the 4th segment of the fore-and midtarsi of the ♂ is expanded like the 2nd and 3rd segments.

A NEW GENUS AND SPECIES OF FUNGUS MOTHS (LEPIDOPTERA, TINEIDAE)

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Moths of the subfamily Nemapogoninae, as distinct from other representatives of the Tineidae, feed on material of vegetable origin: the fruiting bodies of capped fungi and tree fungi, rotting wood and bark, dry fruits, grain, meal, flour and products made from them. Many representatives of this group of moths, being storehouse pests, cause considerable damage at times to stored products. Until recently the control of these moths has been held up by the lack of accurate descriptions of the species. Inability to differentiate the species correctly has led to confusion and to difficulty in studying the biology of individual representatives of this group. In view of this the author has devoted himself to a study of these moths and has made a revision of the subfamily Nemapogoninae (Zagulyaev, 1954).

This article forms part of this revision and constitutes an attempt to investigate the collective group of moths separated by Petersen (1957). Recognizing the great scientific value of the work of Petersen, who, following Pierce (1935), made a systematic study of the species of the genus Nemapogon according to their genital structure, we accept his first three groups of the genus: "granellus," "quercicolellus," "fungivorellus," but we cannot ignore the species which are not included in any of the groups which he established. Lack of knowledge of the features of the external structure of the insects prevented Petersen from sorting out these species and led to their being grouped together in the genus Nemapogon. Having made a study of the external structure of these species of moths and their copulatory organs, we consider it necessary to separate N. parasitella Hb. and N. fulvimitrella Sod. into an independent group, which is distinguished from the other representatives by the structure of the mouth parts, the pattern on the forewings, the structure of the legs and a complex of characters in the male and female genitalia. These structural features differentiate the species N. parasitella Hb. and N. fulvimitrella Sod. not only from Petersen's other groups, but also from all other species of the genus Hemapogon. On these grounds we class these species in an independent genus Triaxomera Zagulajev, gen. n. To this same genus we also assign the new species described. Below we give a diagnosis of this genus.

Genus Triaxomera Zagulajev, gen. n.

Type of genus – Nemapogon fulvimitrella Sod.

The genus is separated from Nemapogon and differs from it in the following characters: In the absence of distinct pilifers and in the short galeae in the mouth parts; pronounced pilosity of antennae in males (length of setae equal to, or considerably greater than, width of flagellar segments), whereas in Nemapogon the antennal segments are bare or are covered with very short setae; the distinctive pattern of the forewings – a dark, broad, cleft spot in the center of the forewing surrounded by paler areas, and anterad of center of inner margin a large dark spot surrounded by pale spots of varying contrast in different species (in species of the genus Nemapogon the pattern of the forewing is in the form of scattered small contrasting spots and streaks on a pale ground); the presence of three spinules on the apex of the tarsal segments (in Nemapogon the spinules are absent or, in rare cases, one is present); the absence in the male genitalia of a finger-like process – the digitus (after Tuxen (1956)) – on the upper side of the apical part of the valva (in all species of Nemapogon the digitus is present and well developed); the very short penis (shorter or slightly longer than valva); the broad, convex, nonmarginate vaginal plate in the female genitalia; the short ductus bursae covered with small spinules; the presence of a

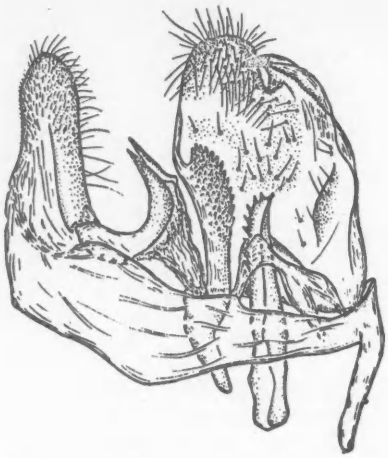

Fig. 1. Triaxomera caucasiella Zagulajev, sp. n. male genitalia.

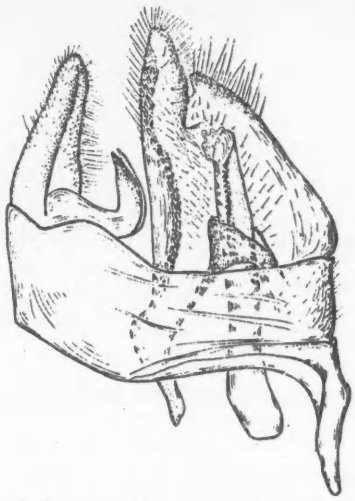

Fig. 2. Triaxomera fulvimitrella Sod., male genitalia.

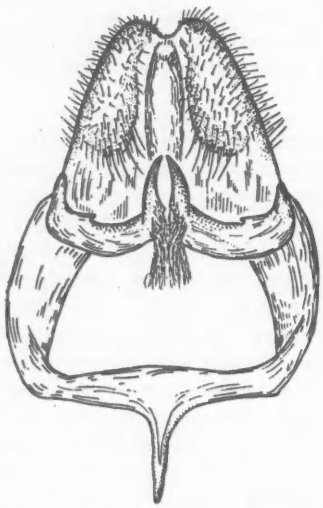

Fig. 3. Triaxomera caucasiella Zagulajev, sp. n., uncus.

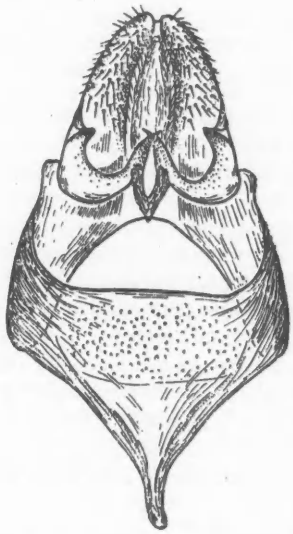

Fig. 4. Triaxomera fulvimitrella Sod., uncus.

sclerotized signa, densely covered with spinules, in the bursa copulatrix (in species of the genus Nemapogon the bursa copulatrix lacks sclerotized formations or they are of different form).

Biology. The caterpillars develop in rotting wood or bark of oak, popular or birch.

The range of the genus includes central and southern Europe, the entire Mediterranean coast, the Caucasus and Transcaucasia.

Triaxomera caucasiella Zagulajev, sp. n.

In outward aspect similar to T. fulvimitrella Sod.

Head densely covered with rumpled yellowish orange hairs, with patches of dark brown scales on occiput

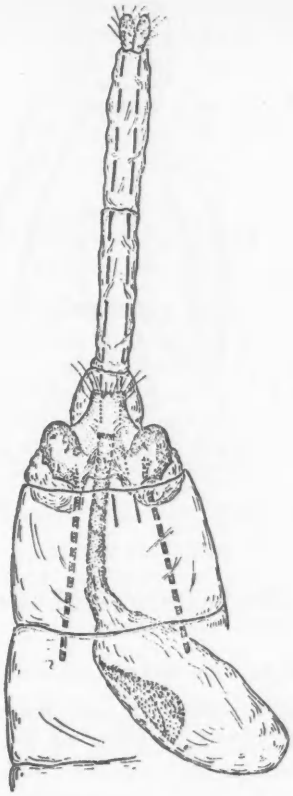

Fig. 5. Triaxomera caucasiella Zagulajev, sp. n., female genitalia.

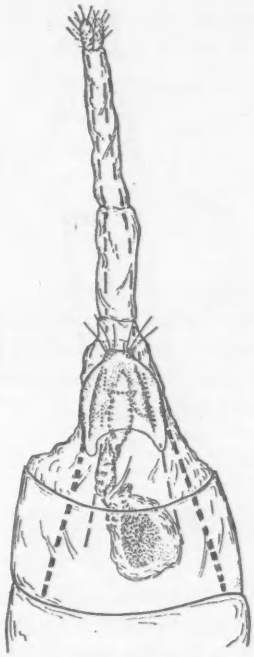

Fig. 6. Triaxomera fulvimitrella Sod., female genitalia.

near eyes. Galeae short, reaching middle of 2nd segment of labial palps. Labial palps in dorsal aspect invested with yellowish white, shining scales. Second segment a little shorter than 3rd, and not longer than it, as in T. fulvimitrella Sod.; in ventral aspect it bears two irregular rows of long blackish brown setae, which form a sparse brush at the apex of the segment and reach middle of 3rd segment. Maxillary palps long, longer than labial palps, geniculate and densely covered with erect, pale yellow, shining scales. Their 4th segment $^{1}/_{3}$ longer than 5th. Eyes small, set wide apart, the distance between them 1½ times as long as long diameter of eye. Antennae $^{2}/_{3}$ of length of forewing, brown with bunches of erect white scales on each segment. First antennal segment large, almost twice as long as broad, covered with pale yellow scales with an admixture of brown scales, and bearing in center 15 long, dark brown setae arranged in two irregular rows; length of setae equal to, or a little longer than width of segment. Second antennal segment half as long as 1st and equal to, or slightly exceeding, its width. Each flagellar segment has several rows of long whitish setae in basal half, the length of these setae being 1½-2 times the diameter of the segment; in ♀ the setae on the antennae are short.

Thorax and forepart of patagium dark brown, shining; patagium terminating dorsally in pale scales.

Forewing span of male 20 mm, of female 21 mm. Length of forewing 3 $^{2}/_{3}$ times as long as broad; length of hindwing twice as long as broad. Fringe of hindwing approximately half as broad as wing.

Coloration and pattern of forewings similar to that of compared species, but with a greyish brown tinge and a diffuser and duller pattern, with no distinct white spots on the blackish brown ground. The two pale spots located on inner margin are more pronounced than those on fore margin. The first spot is $^{1}/_{4}$, the second $^{3}/_{5}$, of distance from base. On the foremargin there are two very diffuse and in distinct spots; the first lies at $^{2}/_{5}$, the second at $^{4}/_{5}$, of the wing length. Between them, at center of foremargin, there is a large, dark brown spot with a small pale streak. All the pale spots are more or less densely dusted with brown scales. Coloration of hindwings brownish grey. Both pairs of wings and their frings shining. Underside of wings with a violet-bronze tinge.

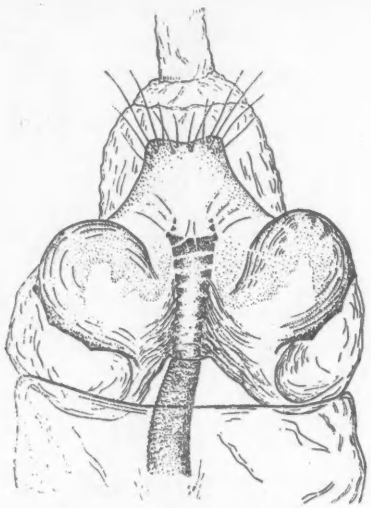

Fig. 7. Triaxomera caucasiella Zagulajev, sp. n., vaginal plate.

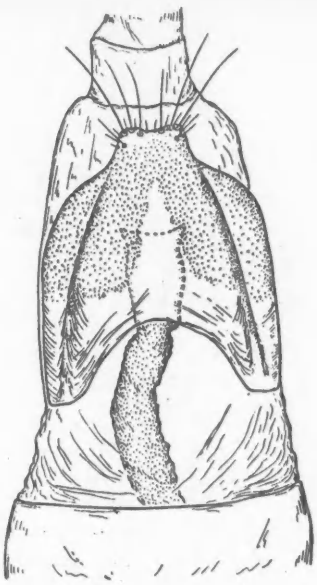

Fig. 8. Triaxomera fulvimitrella Sod., vaginal plate.

Venation of forewing very similar to that of T. fulvimitrella Sod.; the same holds also for venation of hindwing, but M_1 runs into apex of wing and not into the outer margin, as in the latter species.

Legs dark brown, shining. Tibiae of all legs with a pale band in middle; all tarsal segments pale at apex. Middle pair of spurs on hindtibiae at almost $^2/_5$ of length of tibia (in T. fulvimitrella Sod. it is almost in middle). The apex of each tarsal segment bears 3 spinules.

Male genitalia (Fig. 1) similar in general configuration to that of T. fulvimitrella Sod. (Fig. 2). Apex of valva broadly rounded, and not narrowly conical. Basal half of upper margin of valva turned sharply inward, the margin of the bend being covered with coarse blunt spines, whereas in T. fulvimitrella Sod. the entire upper margin is covered with spines. The hook-like process situated on the underside of the apical part of the valva is pointed, strongly recurved and bears a comb of denticles on outer margin. Uncus broad with a rather deep and broad excavation at apex (Fig. 3), and not an inconspicuous one, as in T. fulvimitrella Sod. (Fig. 4). Subunci pointed and arched, but not geniculate. Penis noticeably shorter than valva, and not longer than it, as in T. fulvimitrella Sod. Upper margin of apical part of penis covered with large sharp spines pointing toward apex of penis. Saccus simple, $^3/_4$ of length of penis.

Female genitalia (Fig. 5) similar to that of T. fulvimitrella Sod. (Fig. 6). Vaginal plate (Fig. 7) with knob-line protuberances on sides, broad, its length $^3/_4$ of its breadth, whereas the vaginal plate of T. fulvimitrella Sod. is narrower and lacks knob-like protuberances (Fig. 8). Ductus bursae strongly plicated and densely covered with small spinules. Bursa copulatrix in the form of a narrow sac extending into 5th segment. In one wall of the upper half of the sac there is a conical sclerotized plate, densely covered with rather large spines pointing toward base of sac. The ovipositor is more than three times the length of the 7th sternite. The anterior apophyses reach the 6th segment, the posterior only extend quarter of the way into the 7th segment.

In external aspect, coloration, wing pattern, structure of mouth parts, wing venation, leg coloration, and also in the male and female genitalia the described species is very similar to T. fulvimitrella Sod., but differs distinctly from it in the short second segment of the labial palps, the noncontrasting pattern on the forewings and, in particular, the inconspicuous pale spots on the foremargin, the hindwing M_1, which meets the apex of the wing, the middle pair of spurs on the hindtibiae situated distinctly forward of the middle of the tibiae, the rounded apex of the valvae, the sharp incurving of the upper margin of the valva, the short penis and the vaginal plate with knob-like protuberances.

Biology. The moths were bred out on May 27-28, 1957 from a piece of moist rotten wood and bark of a

mulberry tree. Before the emergence of the moths the pupae projected halfway out of the substrate. The moths emerged at night and toward evening of the following day they mated. Pairing lasted about an hour. Several eggs were laid on May 29. Owing to the death of the caterpillars their further development was not observed.

Distribution. The only two specimens, the holotype ♂ and the allotype ♀, were bred out on May 27-28, 1957 in the village of Paraga, Ordubad District of the Nakhichevan ASSR.

SUMMARY

Genus Triaxomera Zagulajev, gen. n.

The type of the genus is Nemapogon fulvimitrella Sod.

The genus is similar to Nemapogon Schr. and is characterized by short galeae, small eyes widely separated so that the distance between them is 1½-2 times greater than the longitudinal diameter of eyes, by V-shaped dark markings in the middle of costa and a large dark spot before the middle on dorsum of the forewings; by the presence of normally developed M_{1-3} and Cu_{1-2} in hindwings and by the presence of a sclerotized signa in the bursa copulatrix. At the present time this genus comprises three species: T. fulvitmitrella Sod., T. caucasiella Zagulajev, sp. n., and T. parasitella Hb.

Triaxomera caucasiella Zagulajev, sp. n.

Forewings grey-brown with indistinct light markings. The 2nd joint of labial palps shorter than the 3rd one. The basal half of the upper margin of valvae folded inward. Penis somewhat longer than valva. Sclerotized knobs on both sides of the vaginal plate present. – Transcaucasia (Paraga, Ordubad District).

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ON THE TAXONOMY OF THE GENERA BRACON F. AND HABROBRACON ASHM. (HYMENOPTERA, BRACONIDAE) WITH NOTES ON THE SYNONOMY

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The present article appears as a supplement to the author's work devoted to the question of the systematics and zoogeography of the species of Bracon F. and Habrobracon Ashm. (Tobias, 1958) and to the description of new species (Tobias, 1957). All the new species were collected during the field work undertaken in central Kazakhstan in 1957.

I. Description of New Species of Bracon F.

Of the seven species of Bracon described here six belong to the subgenus Lucobracon (Fahringer) Tobias. and one to the subgenus Glabrobracon (Fahringer) Tobias. All of them belong either to sharply separated monotypical groups,or to no less definitely individual groups comprising a very small number of species. Such species, distributed restrictedly over the steppes of the Palearctic region, could be referred to the Pontiac faunistic complex (Telenga, 1952; Tobias, 1958). It should be noted that most of the species of the Pontiac complex recorded by us are, indeed, in the subgenus Lucobracon and, furthermore, only a few such species belong to the subgenus Glabrobracon (Tobias, 1958). Thus, the material from central Kazakhstan confirms this propostion.

Nevertheless, the occurrence of such forms in the genus Bracon is not restricted to the Black Sea steppes; a number of species from central Kazakhstan are described here: a series of species recorded in the steppe regions of Yakutin and the Amur river region, although researches in these districts have only just begun. In Central Kazakhstan species of such "Pontiac" genera as Polydegmon and Foersteria are also found,and from this it might be supposed that their area of distribution will expand still further eastward. Therefore, it is necessary to abandon the name "Pontiac faunistic complex," at any rate so far as it is applicable to the species of Bracon, and call them by their old terms. The genetics of this faunistic complex of braconids is connected with the Pliocene steppe landscapes. The species included here, according to their morphology, are quite ancient and are often characterized by primitive features. To such features we must refer, for example, a dense punctuation of the thorax which, in Bracon, is met with only in the monotypical Central Asian subgenus, Asiobracon Tobias. and in certain species of the subgenus Lucobracon, among them B. (L.) punctithorax Tobias. described here. The primitive nature of this character is demonstrated in the subfamily Braconinae where it appears generally in the supertribe Doryctina which occupies a place at the base of the phylogenetic tree of the family Braconidae (Tobias, 1957). The frequent appearance of primitive characters in such species, their sharp morphological isolation, a rather restricted adaptability to grassy steppes, their infrequency,and, apparently the small areas of distribution of many of them all provide some foundation for assuming them to be Pliocene relics of the steppes. It must be supposed that the sharp morphological demarcation of ancient steppe species appears to be a result of the severe reduction in temperature during the Pleistocene period which fatally influenced the thermophilic steppe fauna (Tobias, 1958). The presence of a large number of ancient steppe species of braconids in the steppe districts of USSR confirms the idea, widely accepted in present-day literature, that the destruction of the steppe landscapes in USSR territory during the glacial period did not take place,but only their displacement to the south (Terasimov and Markov, 1941; Grigor'ev, 1946; Grichuk, 1946; Pidoplichka, 1946; Mil'kov, 1947;Makkov, Grichuk and Chebotareva, 1950; Gerasimov, 1951).

There arises the question: Do the steppes of Kazakhstan appear to be an independent focus of formation

and preservation of the ancient steppe fauna, or do the latter appear only as a part of the fauna of the former greater European steppes? The occurrence here of seven new species in the course of only one summer's work appears to settle the question positively. Nevertheless, it is essential to bear in mind, firstly, that the steppe belt of the European part of USSR cannot be reckoned as fully studied, secondly, and this is most important, the typical steppe landscape virtually did not exist in the European parts; that is why the absence here of certain species of the steppe fauna may, secondarily, be purely anthropogenic. For all that, there is some foundation for assuming the steppes of Kazakhstan to be an independent focus of development and preservation of the ancient steppe fauna. Outstanding here is the presence of a strongly reduced radial cell (Figs. 6, 8, 12, 13) which, up to now, has not been noticed among the species of Bracon of the "Pontiac" complex. The presence of this character all at once in three groups quite distinct from one another compels us to assume that such examples of convergence are caused by some specific local conditions. It is remarkable that the reduction of the radial cell is not peculiar to Glabrobracon species, but only in the well-isolated group of Central Asian species — B. (G.) tekkensis Tel. closely related to B. (G.) parviradialis Tobias, sp. n. described here is such a reduction found. On the contrary, the reduction to a greater or lesser degree of the radial cell in the subgenus Lucobracon seems to be a subgeneric character. Another special feature of the subgenus Lucobracon appears to be a tendency to a shortening and narrowing of the wings. In the species of Lucobracon described here this feature is exhibited, to the greatest degree perhaps, in the whole subgenus. Thus, an obvious tendency to a reduction of wing surface and a closing together of the veins at the base of the wing in Lucobracon is observed. In the majority of the species of the subgenus this evidently should be linked with the fact that they live in open steppe habitats where one of the most significant factors exerting an influence on the life of weak-flying ichneumon flies appears to be wind. On the arid steppes of Kazakhstan with their extremely sparse, herbaceous cover and the constant, strong winds, this factor is very important. Under such conditions the capacity to fly is not so essential; on the contrary, the capacity to resist wind acquires great significance and leads to the reduction of wings and wing venation. These ideas permit one to think that the groups of species described here with strongly reduced wings and radial cell were formed just here, close to the dry, barren steppes; that is, they represent an indigenous nucleus of the steppe fauna of Kazakhstan.

The types of all the insects described below are preserved in the Zoological Institute AN SSSR.

Group Bracon (Lucobracon) kasachstanicus Tobias, sp. n.

Antennae more or less swollen, filiform, short. Thorax elongated, 2-2½ times as long as wide. Hind femora short, swollen; tarsal joints contracted, 2nd equal to or shorter than 3rd. Wings reduced, noticeably shorter than the body; radial cell short, terminating far from the tip of the wing, its anterior edge equal to the length of the stigma; 2nd cubital cell considerably smaller than 1st, smaller than the discoidal; discoidal cell hardly narrowing toward its tip. Abdomen longer than thorax, compressed laterally at the tip, with drawn-out keel; suture between 2nd and 3rd tergites deep, curved; 7th sternite not reaching the tip of abdomen. Ovipositor short, not half as long as abdomen, its valves somewhat broadened at the tip. Body with comparatively sparse, light hairs, the larger part smooth.

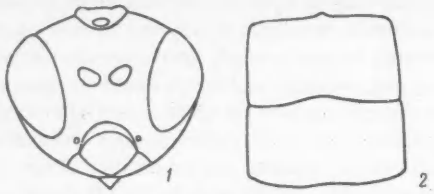
From the majority in the group the subgenus differs very strongly in the reduced radial cell, the short, swollen femora, the short 2nd joint of the posterior tarsi and the short ovipositor. From the related group Bracon (Lucobracon) punctithorax Tobias, sp. n. it differs sharply in the impunctate thorax.

Table for the Determination of the Species of the Group Bracon (Lucobracon)

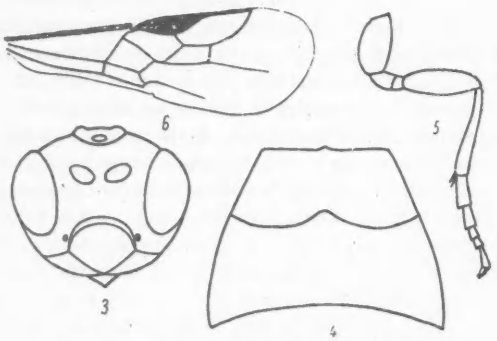
1 (2). Width of oral recess equal to its distance from the eye (Fig. 1). Antennae considerably longer than head and thorax. 2nd tergite equal in length to 3rd; suture between them not strongly curved (Fig. 2) . . . B. (L.) kasachstanicus Tobias, sp. n.

2 (1). Width of oral recess twice as large as its distance from the eye (Fig. 3). Antennae scarcely longer than head and thorax. 2nd tergite considerably longer than 3rd, suture between them strongly curved in the middle (Fig. 4).

3 (4). Hind femora 4 times as long as wide, the larger spur of the hind tibia a little longer than $^1/_3$ the length of the first tarsal joint (Fig. 5). Discoidal cell almost twice as wide as 2nd submedial; radius springs from middle of stigma (Fig. 6). . . B. (L.) akmolensis Tobias, sp. n.



Figs. 1-2. Bracon (Lucobracon) kasachstanicus Tobias, sp. n.: 1) head (from front); 2) 2nd and 3rd abdominal tergites.



Figs. 3-6. Bracon (Lucobracon) akmolensis Tobias, sp. n.: 3) head (from front); 4) 2nd and 3rd abdominal tergites; 5) hind leg; 6) forewing.

4 (3). Hind femora swollen, only 3 times as long as wide, the larger spur of hind tibia, more rarely equal to half the length of 1st tarsal joint (Fig. 7). Discoidal cell a little wider than 2nd submedial; radius springs from beyond middle of stigma (Fig. 8). . . B. (L.) brevifemur Tobias, sp. n.

Bracon (Lucobracon) kasachstanicus Tobias, sp. n.

Female. 3.2 mm. Head transverse; temple one-half the transverse diameter of the eye; width of ocellar field equal to its distance from the eye; longitudinal diameter of eye twice as large as the transverse diameter, 5-6 times longer than the genae; width of face twice its length from the clypeus; width of oral recess equal to its distance from the eye (Fig. 1). Antennae slightly swollen, shorter than body, 31-jointed; joints of palps longer than wide. Thorax almost 2½ times longer than wide; parapsides distinct. Hind femora 4 times longer than wide; last joint of hind tarsi equal to 2nd; larger spur of hind tibia a little longer than $^1/_3$ the length of 1st tarsal joint. Radial cell almost twice the width of 2nd cubital; discoidal cell almost twice as wide as 2nd submedial; radius springs from beyond middle of stigma, its 3rd section curving appreciably to the tip; 2nd section of radius $^1/_2$ the length of 3rd, twice as long as 2nd transverse cubital vein; posterior side of 2nd cubital cell $^1/_3$ the length of the posterior side of 3rd, three times longer than 2nd transverse cubital vein. 2nd tergite equal to 3rd, its length one half of the width at the base, and $^2/_5$ that of its width at the posterior end; suture between 2nd and 3rd tergites not strongly curved (Fig. 2). Ovipositor short, $^1/_3$ as long as abdomen. Intermediate segment punctured and wrinkled, with a small longitudinal ridge, smoother at the base; side of metathorax and face weakly punctured; 2nd tergite wrinkled at middle of base. Black; tips of anterior femora, base of tibia of all legs reddish brown; wings slightly opaque; stigma brown.

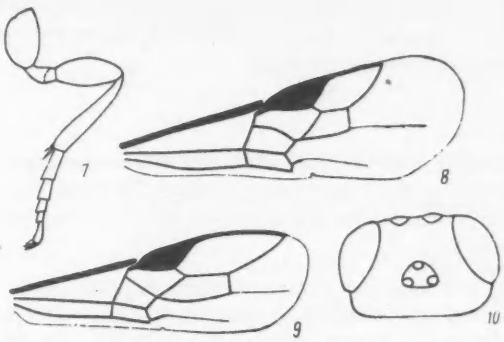
Male not known.

It differs from the other two species of the group in the narrow oral recess, the much longer 2nd tergite and antennae, and the weakly curved suture between 2nd and 3rd tergites.

Material: Akmolinsk region, Kokchetav mountains, steppe, May 15, 1957, 1 female (holotype)(V. Tobias).

Bracon (Lucobracon) akmolensis Tobias, sp. n.

Female. 2.3 mm. Head transverse; temple a little shorter than transverse diameter of eye; width of ocellar field less than its distance from the eye; longitudinal diameter of eye twice as great as its transverse diameter, 5 times longer than genae; width of face 2½ times greater than its distance from clypeus; oral recess twice as wide as its distance from the eye (Fig. 3). Antennae slightly swollen, short, hardly longer than head and thorax, 19-jointed; joints of palps longer than wide. Thorax twice as long as wide; parapsides indistinct. Posterior femora short, 4 times longer than wide; last joint of posterior tarsi a little longer than wide. Thorax twice as long as wide; last joint of posterior tarsi a little longer than 2nd; the larger spur of hind tibia a little longer than $^1/_3$ the length of 1st tarsal joint (Fig. 5). Radial cell twice as wide as 2nd cubital; discoidal cell almost twice as wide as 2nd submedial; radius springs from middle of stigma, its 3rd section strongly curved; 2nd section of radius twice as short as 3rd, almost twice as long as 2nd transverse cubital vein; posterior side of



Figs. 7-10. 7 and 8) Bracon (Lucobracon) brevifemur Tobias, sp. n.: 7) hind leg; 8) forewing; 9 and 10) Bracon (Lucobracon) brevitemporis Tobias, sp. n.; 9) forewing; 10) head (from front).

2nd cubital cell twice as short as posterior side of 3rd, 3 times longer than 2nd transverse cubital vein. 2nd tergite considerably shorter than 3rd, its length one third of its width at the base, one fourth of the width at the posterior end; suture between them strongly curved. Ovipositor half the length of abdomen, thin. Face and genae quite densely punctured, resembling shagreen, intermediate segment along the side of a small longitudinal ridge and the middle of 1st tergite wrinkled. Black; tarsi brown; wings slightly opaque; stigma brown.

Male not known.

It differs from the nearly related Bracon (Lucobracon) brevifemur Tobias, sp. n., the hind femora being less swollen, the larger spur of the hind tibia not so long, and the discoidal cell wider.

Material: Akmolinsk region, 10 km northwest of Lake Zharkol' (south), steppe, May 25, 1957, 1 female (holotype)(V. Tobias).

Bracon (Lucobracon) brevifemur Tobias, sp. n.

Females. 2.8-3.2 mm. Head slightly transverse; temple $^2/_3$ the length of transverse diameter of eye; width of ocellar field less than its distance from eye; longitudinal diameter of the eye $^2/_3$ to twice the transverse diameter, 5-6 times longer than genae; width of face 2-2½ times greater than the length from the clypeus; width of oral recess twice as great as its distance from the eye. Antennae swollen, short, a little longer than head and thorax, 23- to 25-jointed; joints of palps almost quadrate. Thorax, 2½ times longer than wide; parapsides distinct. Posterior femora very short, swollen, only 3 times longer than wide; last joint of posterior tarsi longer than 2nd; the larger spur of posterior tibia more rarely equal to half the 1st tarsal joint (Fig. 7). 2nd cubital cell $^1/_2$ the size of first, $^1/_2$ narrower than radial; discoidal cell a little wider than 2nd submedial; radius springs from behind middle of stigma, its 3rd section uniformly curved; 2nd section of radius $^2/_3$-2 times shorter than 3rd, $^1/_3$-$^1/_2$ longer than 2nd transverse cubital vein; posterior side of 2nd cubital cell $^1/_2$ as long as the posterior side of 3rd, 2½ times longer than 2nd transverse cubital vein (Fig. 8). Abdomen considerably longer than thorax; suture between 2nd and 3rd tergites strongly curved; 2nd tergite considerably shorter than 3rd, its length $^1/_2$ as long as its breadth at the base, almost $^1/_3$ as long as the breadth at the posterior end. Ovipositor $^1/_4$-$^1/_3$ as long as abdomen, or a little longer. Intermediate segment and side of metathorax quite coarsely, less often weakly, punctured, intermediate segment sometimes with a weak, longitudinal ridge; face and genae more or less shagreened by punctures; 2nd tergite wrinkled in the middle. Black; palps, fore legs except base of femora, trochanters, tip of femora, tibia and tarsi of middle and hind legs red-brown; tip of hind tibia, last joint of tarsi, 2nd and 3rd tergites and base of abdomen brown; wings slightly darkened, yellowish at the base; stigma brown. In dark specimens the coxae of the fore legs, trochanters, tip of middle and hind tibia black. In light specimens there are reddish spots or marks above and behind the eyes; base of 4th and tips of 4th-6th tergites sometimes brown, 2nd and 3rd tergites often yellowish; wings sometimes clear.

Males. 1.9-2.8 mm. Face $^2/_3$-2$^1/_2$ times wider than length from the clypeus; genae $^1/_5$-$^1/_7$ times as long as the longitudinal diameter of eye. Antennae equal to or longer than body, thin, 25- to 33-jointed; joints of palps considerably longer than wide. Posterior femora 4 times longer than wide; last joint of hind tarsi equal to 2nd; the larger spur of hind tibia equal to or a little shorter than half the length of 1st tarsal joint. 2nd section of radius $^1/_2$-$^2/_3$ the length of the 3rd, $^1/_4$-2 times longer than 2nd transverse cubital vein; posterior side of 2nd cubital cell often noticeably shorter or longer than posterior side of 3rd. Thorax 2-2½ times longer than wide. In the remaining characters they resemble the females.

It is closely related to Bracon (Lucobracon) akmolensis Tobias, sp. n. from which it differs in the strongly swollen femora, the long larger spur of the hind tibia and the narrow discoidal cell.

Material: Akmolinsk region, 10 km northwest of Lake Zharkol (south), steppe, May 25th-June 11, 1957, 6 females, 17 males (holotype-female, May 28th); steppe, 2 km south of the town of Baizhanzhal, May 27, 1957, 1 female; town of Kokchatav, steppe, May 15, 1957, 1 male (allotype) (V. Tobias).

Bracon (Lucobracon) brevitemporis Tobias, sp. n.

The species forms an independent group which, according to the structure of the legs, form of antennae, abdomen and long ovipositor, is connected with the group Bracon (Lucobracon) kasachstanicus Tobias, sp. n. Nevertheless, it differs from the species of this group in the relatively long radial cell and short temples (Figs. 9, 10).

Female. 1.9 mm. Head transverse; temple short, $^1/_3$ as long as transverse diameter of eye (Fig. 10); width of ocellar field less than its distance from the eye; longitudinal diameter of the eye one half larger than the transverse diameter, 4 times longer than the genae; face twice as broad as its length from the clypeus; oral recess wide, twice the width of its distance from the eye. Antennae slightly swollen, filiform, short, scarcely longer than head and thorax, 20-jointed; joints of palps almost quadrate. Thorax twice longer than broad; parapsides distinct. Hind femora short, 4 times longer than wide; last joint of hind tarsi equal to 2nd; larger spur of hind tibia $^1/_2$ as long as 1st tarsal joint. Wings shorter than body; radial cell long, its anterior edge almost twice longer than stigma; 2nd cubital cell larger than 1st, half as wide as radial, almost twice longer than discoidal; discoidal cell a half wider than 2nd submedial; radius springs almost from middle of stigma, its 3rd section slightly curved, terminating before the tip of the wing; 2nd section of radius half as long as 3rd, twice longer than 2nd transverse cubital vein, posterior side of 2nd cubital cell scarcely shorter than the posterior side of 3rd, 3 times the length of 2nd transverse cubital vein; discoidal cell narrowed toward the tip, its inner side $^2/_3$ longer than the outer, $^1/_2$ as long as the hind side (Fig. 9). Abdomen a little longer than thorax; 2nd tergite equal to 3rd, its length almost $^1/_4$ as long as its width at the base, $^1/_5$ as long as the width at the posterior end; suture between 2nd and 3rd tergites deep, curved; 7th sternite does not reach to end of abdomen. Ovipositor a little longer than half the length of the abdomen, its valves slightly swollen toward the tips. Body with light hairs, the greater part smooth; 2nd tergite weakly striated longitudinally, shining. Black; mouthparts, whole of fore legs, trochanters, tips of femora, tibia except tips, and tarsi of middle and hind legs, 2nd tergite, except middle, lateral edges of 1st and 3rd tergites, anterior abdominal sternites red; wings slightly yellowish and darkened.

Male not known.

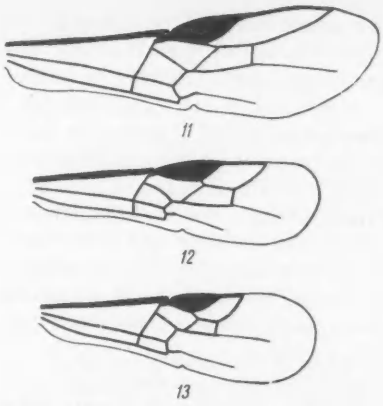
Closely related to the species of the group Bracon (Lucobracon) kasachstanicus Tobias, sp. n. from which it differs in the wing venation and shape of the head. From Bracon (Lucobracon) guttiger Wesm., which is similar in sculpturing, width of oral recess, shape of abdomen and short ovipositor, it differs sharply in its short temples, swollen femora, short wings and antennae and in other characters.

Material: Akmolinsk region, 10 km northwest of Lake Zharkol (south), mixed grassy depression in the steppe, on the flowers of milkwort, June 10, 1957, 1 female (holotype) (V. Tobias).

Bracon (Lucobracon) brachypterus Tobias, sp. n.

It belongs to the group Bracon (Lucobracon) xanthostigmus Kok. with which it is loosely allied by the structure of the abdomen (generally the shape of the 2nd and 3rd tergites), thorax, head, antennae, legs and venation of the forewings.

Females. 3.4-4.5 mm. Head slightly transverse; temple a little shorter than the transverse diameter of the eye; width of ocellar field less than its distance from eye; longitudinal diameter of the eye $^1/_2$-$^2/_3$ greater than the transverse diameter, 4-5 times longer than genae; face $2\frac{1}{2}$-3 times wider than its length from the clypeus; oral recess 2-3 times wider than its distance from the eye. Antennae slightly swollen, filiform, short, equal to length of head and thorax, 22- to 26-jointed; joints of palps longer than wide. Thorax almost twice longer than wide, compressed from above downward ; parapsides distinct. Hind femora 4-$4\frac{1}{2}$ times longer than wide; last joint of posterior tarsi a little smaller than 2nd, larger than 3rd; the larger spur of hind tibia more than $^1/_3$, but less than $\frac{1}{2}$, the length of 1st tarsal joint. Wings considerably shorter than body, narrow; radial cell narrow, equal to or scarcely wider than 2nd cubital, its anterior edge considerably longer than the stigma; 2nd cubital cell smaller than 1st; larger than or almost equal to the discoidal, discoidal cell wider than 2nd submedial;



Figs. 11-13. Forewings: 11) Bracon (Lucobracon) brachypterus Tobias, sp. n; 12) Bracon (Lucobracon) punctithorax Tobias, sp. n.; 13) Bracon (Glabrobracon) parviradialis Tobias, sp. n.

radius springs from middle of stigma; its 3rd section almost straight, terminating quite a long way from the tip of the wing; 2nd section of radius $^1/_3$-$^2/_3$ the size of the 3rd, $^2/_3$ – 2 times longer than 2nd transverse cubital vein; posterior side of 2nd cubital cell $^1/_3$-$^1/_2$ the length of the posterior side of 3rd, 2½-3 times longer than transverse cubital vein; discoidal cell narrows outwardly, its inner side $^1/_4$-$^1/_2$ longer than its outer side, $^1/_2$-$^1/_3$ the length of the posterior side (Fig. 11). Abdomen long, $^1/_2$ to almost 2 times longer than thorax, compressed laterally toward the tip, with keel; 2nd tergite equal to 3rd, almost quadrate, its length approximately equal to its breadth at base, a little less than the breadth at the posterior end; suture between 2nd and 3rd tergites deep, almost straight; 7th sternite projects beyond end of abdomen. Ovipositor equal to or a little shorter than abdomen, its valves thin, equally wide throughout their length. Body with light hairs, the larger part smooth; 1st tergite along the edge of the central part and 2nd tergite around the medial, longitudinal ridge wrinkled longitudinally. Light forms: reddish yellow; antennae, except basal joint, middle of intermediate segment, abdominal tergites except lateral edge of 4th, 5th and last tergites, black; face, mouthparts, genae, base of prothorax, anterior abdominal sternites yellow; wings slightly opaque, stigma yellow. Dark forms: black; head except middle of vertex, frons and face, spot behind the eyes, palps, spots along the parapsides, prothorax except front part, middle of side of mesothorax, side of metathorax, legs except coxae, stripes along upper side of middle femora, base of hind femora and tip of hind tibia, last abdominal tergites and sternites reddish brown; bottom of pronotum and basal abdominal sternites yellowish; wings slightly opaque, stigma brownish. Direction of color change (in series): the darkening of the thorax (not counting the intermediate segment) begins with the base of the mesothorax; then the prothorax darkens and the spots on the middle and lateral lobes of the mesothorax; the latter appear sooner than the darkening of the legs and ocellar field; the darkening of the hind legs outstrips that of the middle legs, beginning at the same time as the coxae, base of femora and tip of tibia; on the head the black color extends from the ocellar field to the middle portion of the vertex, occiput, frons and face, running parallel with the darkening of the mouthparts.

Males similar to the females. 2.8-3.6 mm.

Closely related to Bracon (Lucobracon) xanthostigmus Kok. from which it differs in the considerably shorter ovipositor, shorter genae, lesser number of antennal joints and different relationship between 2nd and 3rd sections of the radius.

Material: Akmolinsk region, 10 km northwest of Lake Zharkol (south), steppe, May 25, June 11, 1957, 9 females, 9 males (holotype-female, May 25th); steppe near valley of river Teresakkan, opposite the town of Kokshetav, on flowers of Ferula tatarica, June 13, 1957, 6 females, 12 males; 10 km north of Lake Zharkol' (south), steppe, on flowers of Ferula caspica, June 17, 1957 1 female, 1 male; valley of river Shabdar, 20 km from the mouth, on flowers of Palimba rediviva, June 21, 1957, 2 females; 6 km northwest of Lake Ilektykol' steppe, on flowers of Ferula soongorica, June 25, 1957, 6 females; valley of river Teresakkan opposite the town of Kokshetav, on flowers of Palimba rediviva July 2, 1957, 1 female; same locality, on Ferula tatarica, July 13, 1957, 3 females (V. Tobias).

Bracon (Lucobracon) punctithorax Tobias, sp. n.

The species forms an independent group differing from other groups of species of the subgenus Lucobracon in the almost completely punctured thorax.

Female. 2.3 mm. Head slightly transverse; temple two thirds the transverse diameter of the eye; width of ocellar field equal to its distance from the eye; longitudinal diameter of eye $^2/_3$ greater than transverse diameter, 6 times longer than genae; face half as wide as its length from the clypeus; width of oral recess a

little longer than its distance from the eye. Antennae slightly swollen, filiform, short, scarcely longer than head and thorax, 20-jointed; joints of palps longer than wide. Thorax 2½ times longer than wide, parapsides distinct. Hind femora short, dilated, 3 times longer than wide; last joint of hind tarsi considerably larger than 2nd; larger spur of hind tibia half as long as 1st tarsal joint. Wings shorter than body, narrow; radial cell short, its anterior edge as long as stigma; 2nd cubital cell smaller than 1st, half as wide as radial, considerably larger than discoidal; discoidal cell equal in width to 2nd submedial; radius springs from behind middle of stigma, its 3rd section curved, 2nd section of radius $^1/_2$ length of 3rd section, almost twice the length of the 2nd transverse cubital vein; posterior side of 2nd cubital cell $^1/_3$ the length of posterior side of 3rd, almost 3 times longer than 2nd transverse cubital vein; discoidal cell contracts outward, its inner side twice as long as the outer side, length $^1/_2$ that of posterior side (Fig. 12). Abdomen longer than thorax, compressed laterally at the tip, with keel; 2nd tergite a little shorter than 3rd; its length $^2/_5$ as great as its width at the base, $^1/_3$ as great as its width at posterior end; suture between 2nd and 3rd tergites deep, strongly curved; 7th tergite does not reach the end of the abdomen. Ovipositor half as long as abdomen, its valves slightly dilated toward their tips. Body with light hairs. Head except face and genae, mesothorax except parapsides, scutum, legs except posterior coxae, abdomen except 1st-2nd tergites smooth; face and genae, larger part of thorax, 1st and 2nd abdominal tergites punctured like shagreen, dull; intermediate segment with weak, double, longitudinal ridges. Black; palps, anterior coxae, tips of femora of middle and fore legs tibia except tips of middle and hind legs, tarsi reddish brown; wings slightly obscured by yellowish tinge.

Male not known.

Closely related to the species of the group Bracon (Lucobracon) kasachstanicus Tobias, sp. n., in habitus, structure of the leg, antennae, size of radial cell; it differs sharply in the puncturated thorax and also in the outwardly tapering discoidal cell and the comparatively large 2nd cubital cell and narrow face.

Material: Akmolinsk region, 10 km north of Lake Zharkol (south), steppe, May 24, 1957, 1 female (holotype) (V. Tobias).

Bracon (Glabrobracon) parviradialis Tobias, sp. n.

The species forms an independent group, sharply differentiated by the very strongly contracted radial cell (Fig. 13), having no similarities among the species of the subgenus Glabrobracon or among those of the subgenus Lucobracon. It is related to the species of the group Bracon (Glabrobracon) tekkensis Tel. in having a clearly marked tendency to contraction of the radial cell and also a similar structure of the head (long genae, small oral recess), abdomen (weak suture between 2nd and 3rd tergites), legs, antennae and short ovipositor.

Female. 1.7 mm. Head transverse; temple half as wide as transverse diameter of the eye; width of ocellar field considerably smaller than its distance from the eye; longitudinal diameter of eye a half smaller than the transverse diameter, a half longer than the genae; face almost twice as wide as its length from the clypeus; width of oral recess smaller than its distance from the eye. Antennae thin, slightly bristle-like, a little longer than the body, 23-jointed; joints of palps twice longer than wide. Thorax $^2/_3$ longer than wide; parapsides indistinct. Posterior femora thin, 6 times as long as wide; last joint of hind tarsi smaller than 2nd, larger than 3rd; larger spur of hind tibia very short. Wings a little longer than body; radial cell very short, its anterior edge one half the length of the stigma; 2nd cubital cell half the size of the 1st, half the width of the radial, almost half the size of the discoidal; discoidal cell twice as wide as the 2nd submedial; radius springs from middle of stigma, its 3rd section curved, terminating considerably nearer to stigma than to tip of wing; 2nd section of radius almost half the length of the 3rd, a half longer than 2nd transverse cubital vein; posterior side of 2nd cubital cell $^1/_3$ times the posterior side of 3rd, twice as long as 2nd transverse cubital vein; discoidal cell slightly contracted outwardly, almost quadrate (Fig. 13). Abdomen a little longer than thorax, compressed laterally at the tip, with a keel; 2nd tergite equal to 3rd, its length $^2/_5$ that of its width at the base, $^1/_3$ of its width posteriorly; suture between 2nd and 3rd tergites weak, scarcely curved; 7th sternite ends near tip of abdomen. Ovipositor a little longer than half the length of the abdomen, its valves thin, uniform in size throughout their whole length. Body with light hairs, almost uninterruptedly smooth; edge of face and mesonotum in front of scutum weakly puncturated, shining. Black; anterior abdominal sternites yellowish; tips of femora, base of tibia and tarsi of middle and fore legs and base of hind tibia brownish. Wings clouded by yellow tinge; stigma brown.

Male not known.

Closely related to the species of the group Bracon (Glabrobracon) tekkensis Tel. from which it is differentiated by the unusually contracted radial cell and other features in wing venation.

Material: Akmolinsk region, 10 km northwest of Lake Zharkol'(south), steppe, May 24, 1957, 1 female (holotype) (V. Tobias).

II. New Synonyms for Bracon F. and Habrobracon Ashm.

More than 20 years ago there appeared the well-known book by N. A. Telenga, clarifying the systematics of the subfamily Braconinae which includes Bracon, the largest genus of the family Braconidae (Telenga, 1936). At that time many dozens of species of Bracon, and the closely allied Habrobracon, were already described from western and central Europe, but the Palearctic region, to which the Soviet Union belongs, remained to a considerable degree as a white patch.

It is quite obvious that our large country with its endlessly varied landscapes and habitats cannot provide systematics with an exceptional number of forms which agree with the identification tables and descriptions of European authors. Of course, that is the reason why Telenga was obliged to describe about 60 species of Bracon and Habrobracon even from the comparatively small amount of material accumulated from Soviet territory over a 30-year period. In the absence of a long series of insect species which could have provided the possibility of estimating the range of variation in characters, and with the extensive use at that time of color as the principal criterion in separating species it can be understood why Telenga was unsuccessful in avoiding synonyms in his work on the material from Central Asia, where the sharp contrasts of temperature between day and night, spring and summer, plain and mountain are particularly strong in affecting the variability of this character.

At the present time the existence of large series of insects showing species variation, principally from Central Asia and Kazazhstan, permits the study of the variability of a number of important diagnostic features such as color, abdominal sculpturing, wing venation and number of antennal joints which were widely employed up to recent times (Tobias, 1958). The synonomy cited below is chiefly the result of research on the variation of the characters in serial material and are based on the study of types preserved in the Zoological Institute, AN SSSR, and in the collections of N. A. Telenga. The majority of the new synonyms, except the last two, have already been mentioned earlier (Tobias, 1958).

The author is pleased to record his sincere acknowledgements to Prof. N. Telenga for allowing him to make use of his collections of material.

1. Habrobracon hebetor Say, 1836 (= H. flavus Telenga, 1926; syn. n.). H. flavus Tel., described from Bukhara (Sept. 22, 1931, female), appears to be only a light colored variation of H. hebetor Say. common in Central Asia. The characteristic features in the wing venation and in the thickness of the antennae, noticed by Telenga, are also common among dark varieties of H. hebector Say. and are subject to important individual variations; they cannot be accepted as specific.

2. Habrobracon hebetor Say, 1936 (= H. turkestanicus Telenga, 1936; syn. n.). The Central Asiatic H. turkestanicus Tel. [Bukhara, July 9, 1927, female (Yakhontov)] does not differ in color from the light variant of H. hebetor Say. The principal character on the basis of which the species was formed by Telenga — the contracted 2nd cubital cell — appears to be the result of a wrinkling in the wing membrane in the region of the 2nd transverse cubital vein, a character quite often met with in species of Bracon and Habrobracon; in certain paratypes this character is absent. We were not successful in finding appreciable differences in the thickness of the femora when comparing typical specimens of H. turkestanicus with H. hebetor Say.

3. Habrobracon nigricans Szepligeti, 1901 (= H. mongolicus Telenga, 1936; syn. n.). H. mongolicus Tel, was described from Central Asia [eastern Tsaidam, Kurlyk, Banigol, May 21, 1895, female (Roborovskii, Kozlov)]. The remark in the description about its being distinguished from H. nigricans Szep. by its smooth thorax and abdomen is not accurate. They are distinctly punctuated even though weakly. A similar sculpturing of the body is quite often met with in H. nigricans Szepl. obtained from various localities.

4. Bracon flasus Kokujev, 1913 (= B. olgae Telenga, 1936; syn. n.). B. olgae Tel., described from the Mugodzhar mountains [July 8, 1932, female (Lik'yanovich)] differs from B. falsus Kok., according to the identification table (Telenga, 1936: 145), in the head being slightly contracted posteriorly, in the wing venation and in the much longer ovipositor. A series of B. falsus Kok. from western Kazakhstan (Kar'kin, June 3rd- July 12,

1951, 12 females, 9 males (V. Tobias, V. Rudol'f)), available in the Zoological Institute, AN SSSR, shows that these characters vary fairly widely, covering all the named characters of B. olgae Tel. which, consequently, appears to be only a variant of B. falsus Kok. It should be remarked that the wide variation of wing venation is found in large series and ranges of other species of Bracon (Tobias, 1958).

5. Bracon trucidator Marshall, 1888 (= B. tauricus Telenga, 1936; syn. n.) Bracon trucidator Tel. is described from two specimens from Yalta (September 8, 1930, female, male (N. Telenga)) and referred to the section Glabrobracon Fahringer., species which have a completely smooth abdomen. Nevertheless, on the tergites of typical specimens some sculpturing is noticed, even though it is weakly marked. At the same time the larger series of B. trucidator Marsh. from Ul'yanovsk [August 23rd- 30, 1954, 80 females, 17 males; a parasite Metzneria lappella L. in heads of agrimony, September 1954, 4 females, 9 males, June 1955, 37 females, 28 males (V. Tobias)] and of the closely allied B. nigripedator Nees. from Turkmen [Kara-Kala, May 13-28, 1955, 985 females, 349 males (V. Tobias)], which has, as a rule, a roughly wrinkled abdomen and belongs to the section Striobracon Fahringer. (subgenus Striobracon Tobias), indicate that in a few specimens of this species the sculpturing can be reduced to almost complete disappearance. The presence of a weak sculpturing on the tergites in specimens of B. tauricus Tel. which, in other respects, is not different from B. trucidator Marsh. leaves no doubt whatever that the first is only a variant of the second. This conclusion is corroborated by the fact that a small series of B. trucidator Marsh. [Yalta, September 2, 1930, 5 females (N. Telenga)] was collected at the same time and place as B. tauricus Tel.

6. Bracon erythrostictus Marshall, 1885 (= B. segregatus Telenga, 1936; syn. n.). B. segregatus Tel. described from Krasnoyarsk [July 1, 1912, female (Kazantsev)], differs from the 'typical' B. erythrostictus Marsh. in the dark palps and wrinkled intermediate segment. A study of serial material of B. erythrostictus Marsh., in particular a series from western Kazakhstan [Kar'kin, May 24-July 19, 1951, 68 females, 21 males (V. Tobias, V. Rudol'f)], showed that these characters were subject to considerable individual variation. This is shown in the sculpturing which, to a greater or lesser degree, always appears on the tip of the intermediate segment. In certain specimens this tree-like sculpturing extends as far as the middle of the intermediate segment and even to its base. The black palps are usually found in dark specimens of B. erythrostictus Marsh. and are linked with varieties having light palps by a continuous range of blends. In this way the color of the palps in B. erythrostictus Marsh. is directly related to the color of the body, the latter varying with temperature conditions prevailing during the development of the parasite and with the size of its body (Tobias, 1958). B. segregatus Tel. represents one of the extreme variations of B. erythrostictus Marsh.

7. Bracon venustus Telenga, 1936 (= B. temporalis Telenga, 1936; syn. n.). B. temporalis Tel., according to the description, differs from B. venustus Tel. in the lighter color of the body, the light wings (in B. venustus Tel. they are slightly smokey) and the smaller number of antennal joints (in B. venustus Tel. there are 28, in B. temporalis Tel. 26). On the basis of material examined from various localities it can be accepted that the color of the wings and body of B. venustus Tel. varies widely, becoming even much lighter than that in B. temporalis Tel. (body almost completely reddish yellow), and smokey wings can be observed in light specimens [for example, in a series from the Akmolinsk Region, 10 km north of Lake Zharkol'(south), May 29, 1957, 6 females, 1 male (V. Tobias)]. The numbers of antennal joints found in specimens of B. venustus Tel. in the collections of the Zoological Institute, AN SSSR, vary from 28-36. It is obvious that this character cannot be taken as diagnostic particularly if it is considered that the number of antennal joints is directly related to body size (Tobias, 1958). Thus, B. temporalis Tel. described from Turkmen (Ashkhabad, April 21, 1929, male [A. Shestakov)] must be acknowledged to be a synonym for the widely spread B. venustus Tel.

8. Bracon discoideus Wesmael, 1838 (= B. kirgisorum Telenga, 1936; syn. n.). Described from Kirgiz [Saribulak, July 5, 1927, female (Shtamberg)] B. kirgisorum Tel. appears to be a dark variety of B. discoideus Wesm. (legs and edge of abdomen black) linked with the basic form by a series of gradations.

9. Bracon tshitsherini Kokujev, 1904 (= B. ochrostigma Telenga, 1936; syn. n.). B. ochrostigma Tel. is described in the same way as B. tshitsherini Kok. from Central Asia [Kammashi, June 27, 1931, female, male (V. Gussakovskii)] and differs from it in the dark color of the body. Nevertheless, the reddish yellow body color, although a usual feature in B. tshitsherini Kok., is far from being constant. The frequent occurrence of a light body color in B. tshitsherini Kok. from Central Asia is probably due to the high summer temperatures in which the parasite develops. At the same time, generally in small specimens, the body can often be very dark, almost completely black as was described by us (Tobias, 1958) from a long series of specimens from Kara-Kala (Turkmen). B. ochrostigma Tel. corresponds exactly to one of the variants of this series.

10. Bracon tshitsherini Kokujev, 1914 (= B. helleni Telenga, 1936; syn. n.). This same series shows that the slight darkening at the base of the wings and the proportions in the wing venation of B. helleni Tel. [(Ural'sk, July 9, 1927, female (Pobedimov)] also represents only a variant of B. tshitsherini Kok. The venation in B. tshitsherini Kok. varies very widely (Tobias, 1958).

11. Bracon hemiflavus Szepligeti, 1901 (= B. turcmenus Telenga, 1936; syn. n.). Arising from the study of a large series of B. hemiflavus Szepl. from Turkmen [Tashkepri, April 24-June 12, 1954, 33 females, 30 males; March 29-April 17, 1955, 94 females, 159 males (V. Tobias)] B. turcmenus Tel. described from Ashkhabad [April 21, 1929, female (A. Shestakov)] appears to be a dark colored, spring form of B. hemiflavus Szepl. (Tobias, 1958). According to all other characters, except color, B. turcmenus Tel. is completely identical to B. hemiflavus Szepl.

12. Bracon variator Nees, 1811 (= b. ornulatus Telenga, 1936; syn. n.). B. ornulatus Tel. is described from northwest Kita [Gashun'sk Gobi, Sachzhou July 20, 1895, 3 females (Roborovskii, Kozlov)] and, according to the description has a considerably lighter colored body than B. variator Nees. Nevertheless, as the serial material from a number of localities in Central Asia shows, the color of B. variator varies widely from almost wholly red to wholly black. B. ornulatus Tel. corresponds exactly to one of the variants of this species.

13. Bracon abscissor Nees, 1934 (= B. rufigaster Szepl. var. notatus Telenga 1936; syn. n.). B. rufigaster var. notatus Tel. (Kherson, Nerubaevsk resort, July 19, 1900, female) differs from the 'typical' B. abscissor Nees. (according to the description having an entirely smooth abdomen) in the sculpturing of the 2nd tergite. Nevertheless, B. abscissor Nees. as a rule has a rather weak, well-leveled, but for all that a decided, sculpturing at the base of the abdominal tergites. This sculpturing in B. abscissor Nees. may be reinforced by imperceptibly connected forms which relate it with that of B. rufigaster var. notatus Tel. It is probable that B. rufigaster Szepl., as far as one can judge from its very concise description, is also a synonym for B. abscissor Nees.

14. Bracon gusaricus Telenga, 1933 (= B. pulcherrimus Telenga, 1936; syn. n.). The holotype B. pulcherrimus Tel. [Tiflis, Antsal'-or pass, July 17, 1913, female (A. Mlokosevich)] differs from the holotype B. gusaricus Tel. (Guzar April 19, 1929) only in its lighter color and greater number of antennal joints. The material from various localities in Central Asia and Zakavkaz' (18 females, 8 males) easily links these forms by a chain of imperceptible gradations.

15. Bracon gusaricus Telenga, 1933 (= B. depressus Telenga, 1936; syn. n.). According to all characters, except the impressing of the mesothorax (on the basis of which the species was formed), B. depressus Tel. [Tadzhikistan, Darvaz July 9, 1915, female (Lazdin)] does not differ from B. gusaricus Tel. Nevertheless, the impressing of the mesothorax appears to be the result of mechanical deformation (by sweeping) traces of which are also seen on the head and scutum.

16. Bracon ovoides Telenga, 1936 (= B. shestakovi Telenga, 1936; syn. n.). The holotype B. shestakovi Tel [Bayram-Ali, April 14, 1932, female (P. Bogush)] differs from the holotype B. ovoides Tel [Kizyl-Kum, July 19, 1912, female (H. Zarudnyi)] only in its somewhat darker color and the smaller dimensions of the body. These characters are far too unimportant for separating these specimens into two different species. The remarks in the description about the short thorax in B. ovoides Tel. are not accurate; as in B. shestakovi it is twice as long as broad. The other differences between them mentioned in the description (somewhat more abruptly terminating intermediate segment with a slight depression in the middle in B. ovoides Tel. and the slightly longer 2nd tergite in B. shestakovi Tel.) are very minor ones and do not exceed the limits of the usual individual variability in other species of Bracon.

17. Bracon hedwigae Schmiedeknecht, 1896 (= B. carinatulus Telenga, 1936; syn. n.). B. carinatulus Tel. is described from Central Asia [Kammashi, May 27, 1931, female (V. Gussakovskii)] on the basis of the absence of wrinkling on the intermediate segment. The material from Central Asia (in particular the fairly large series from Uzbekistan; Changir, April 23, 1930, 10 females, 10 males) shows that the sculpturing on the intermediate segment in B. hedwigae Schm. varies a great deal and may sometimes be entirely absent. Such specimens do not differ from B. carinatulus Tel.

18. Bracon suchorukovi Telenga, 1936 (= B. dobrovolskii Telenga, 1936; syn. n.). Described from the Ukraine [Sinel'nikovo, June 10, 1930, female (V. Talitskii)] B. dobrovolskii Tel. corresponds completely to one of the variants among a large series of B. suchorukovi Tel. from west Kazakhstan (June 1-July 16, 1951, 51 females, 55 males [V. Tobias, V. Rudol'f,]. Information on the swollen thorax in the description of B. dobrovolskii Tel. is

inaccurate since in the holotype, as in B. suchorukovi Tel., it is elongated and slightly compressed from above downward The difference in the thickness of the antennae mentioned in the identification table (Telenga, 1836 : 173) is also not observed: in the holotype B. dobrovolskii Tel. and in the holotype B. suchorukovi Tel., as in all other examples in the series from west Kazakhstan, they are dilated.

Until the author became acquainted with the types from N. A. Telenga's collections the series B. suchorukovi Tel. was incorrectly identified (Tobias, 1954) as B. indubius Szepl.

III. Types for the Subgenera Bracon F. and Habrobracon Ashm.

In the author's works (Tobias, 1957, 1958) descriptions and subgeneric identification tables were given for the genera Habrobracon and Bracon, based partly on the sections formed earlier by Fahringer, the names of these sections having been retained (Fahringer, 1927-1928). Nevertheless, types for the separate subgenera were not established. The species adopted by us for the subgenera are given below

Genus Habrobracon Ashm.
Subgenus Habrobracon s. str.
Type for subgenus Bracon hebetor Say, 1936.
Subgenus Opthalmobracon Tobias.
Type for subgenus Bracon opthalmicus Telenga, 1933.

Genus Bracon F.
Subgenus Bracon s. str. = Striobracon (Fahringer) Tobias.
Type for subgenus Ichneumon minutator Fabricius, 1798.
Subgenus Glabrobracon (Fahringer) Tobias.
Type for subgenus Bracon variator Nees, 1911.
Subgenus Orthobracon (Fahringer) Tobias.
Type for subgenus Bracon exhilarator Nees, 1834.
Subgenus Lucobracon (Fahringer) Tobias.
Type for subgenus Bracon suchorukovi Telenga, 1936.
Subgenus Cyanopterobracon Tobias.
Type for subgenus Bracon sabulosus Szepligeti. 1896.
Subgenus Rostrobracon Tobias.
Type for subgenus Ichneumon urinator Fabricius, 1798.
Subgenus Asiobracon Tobias.
Type for subgenus Bracon quadrimaculatus Telenga, 1936.

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THE PALEARCTIC SPECIES OF THE GENUS CHRYSOGASTER Mg. (DIPTERA, SYRPHIDAE)

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Species of the genus Chrysogaster Mg. are small diptera usually found on umbelliferous flowers, white Compositae (Chrysanthemum, Achilae), Ranunculi, Cruciferae (Barbarea) and others; species of this genus select for their habitation well-insulated situations (edges of forests, clearings, railroad grades, etc.), arranged as a rule, near reservoirs; of the widely distributed species the more xerophilous species is Chrysogaster chalybeata Mg., and the more hygryophilous are Ch. viduata L., Ch. macquarti Lw. and Ch. solstitialis Fln., the latter, unlike the other species, prefer more shaded situations. The larvae of those species, whose development is known, inhabit water; the larvae of Ch. hirtella Lw. bore into the roots of aquatic plants (Glyceria aquatica) with the posterior end of the body, taking the oxygen found in the air-carrying fascicles of the plants (Coe, 1953: 48).

Phenological species of the genus Chrysogaster are adapted to the end of spring and summer (May-August), some of them characteristically and mainly to the first half of summer (Ch. viduata L., Ch. jaroslavensis Stack; they occur predominantly on the flowers of Ranunculus, Caltha, Barbarea), others to the middle and end of summer (in particular Ch. chalybeata Mg., usually on flowers of Pimpinella saxifraga).

The zoogeographical genus Chrysogaster gravitates to the temperate zone of Palearctica and Nearctica; the species of the genus characteristic of arid subtropical Palearctica (Middle and Central Asia) are adapted there usually to the middle (forest) mountain zone or else to depressions abundant in water (river valleys).

DESCRIPTION OF THE GENUS

Medium sized flies with a large head. Body black or greenish-black. Eyes of the male are contiguous on the vertex; the facets on the upper portion of the eyes are larger; the margin between the larger and smaller facets is abrupt. Vertex of the male convex, as a rule, slightly bulged. Vertex in the females of most species with transverse furrows. Frons of the male with a more or less pronounced median protuberance. Frons of the female with a depression below the antennae, without a median protuberance, edge of the mouth raised. Antennae short; third segment of insignificant size, rounded. Abdomen oval, central area of dorsum dull, dorsum very rarely shiny. Posterior femur with short bristles below. rm arranged above the basal third of M_2; the apical section of M is, as a rule, curved in an S-shape, does not have a return course, and runs into r_{4+5} at a right angle.

Fourteen species of the genus are known from Palearctica.

KEY TO THE SPECIES

1 (16). Antennae black.

2 (11). Wing bases dark, greyish or brownish. Body blackish.

3 (4). Pleura greyish, lightly pollinose. Halteres yellow. Frons of the male, except for the median protuberance and edge of the mouth, is greyish and densely pollinose. The frontal protuberance and edge of the mouth distinctly protrude forward (Fig. 1,1). Vertex of the male shiny, slightly bulged, with a small oval depression; vertex of the female moderately broad, tapered toward the top, the upper part is equal to about ½ the breadth of the eye, with barely noticeable transverse furrows. Mesonotum of the male shiny brownish black,

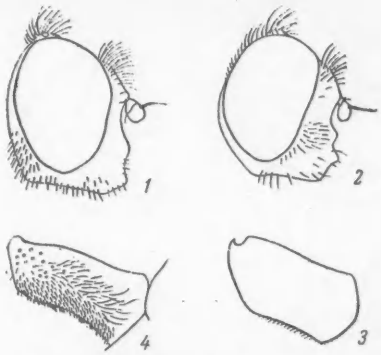

Fig. 1. 1) Chrysogaster pollinifacies Viol., male, head in profile; 2) Ch. tumescens Lw., male, same; 3) Ch. tumescens Lw., male, gonocoxite; 4) Ch. macquarti Lw., male gonocoxite.

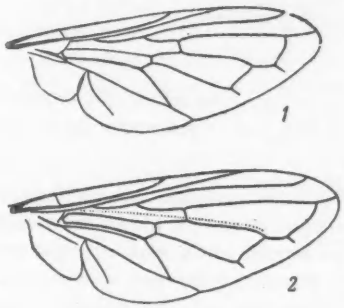

Fig. 2. 1) Chrysogaster tumescens Lw., male, wing; 2) Ch. macquarti Lw., wing.

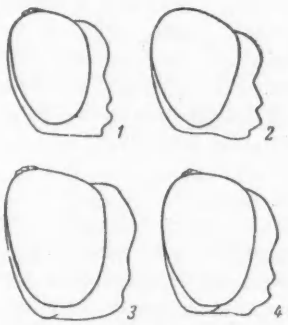

Fig. 3. 1) Chrysogaster hirtella Lw., male, head in profile; 2) Ch. macquarti Lw., male, same; 3) Ch. chalybeata Mg., male, same; 4) Ch. virescens Lw., male, same. (After Coe).

sparsely and finely punctate, with moderately long, dark projecting hairs; mesonotum of the female with relatively short, light, projecting hairs, to which is added a quantity of longer, likewise projecting, hairs. Wings slightly darkened. Abdomen of males and females brownish black; the second and third tergites, except for the lateral edge, and a small spot on the anterior edge of the fourth tergite, dull black. 8.5 mm. USSR: Sakhalin I. . . . Ch. pollinifacies Viol. 1956. Violovich, 1956, Entom. Obzr. XXXV.

4 (3). Pleura, except for propleura and pleurotergite, shiny black. Halteres dark, blackish brown or brown. Frons of the male shiny black, only below antennae greyish, pollinose.

5 (6). Entire venter of the male abdomen covered with sparse, contiguous, light hairs. Mesonotum, scutellum and pleura of the female with very short (almost unnoticeable), dark hairs. Entire dorsum of the female abdomen shiny black. Frons of the male broad, with a sloping median protuberance; edge of the mouth protrudes forward more strongly than the median protuberance. Vertex of the male broad, strongly bulged, with a small oval depression. Frons and vertex of the female broad, almost twice the breadth of the eye (as viewed from the front); vertex of the female with transverse furrows, which are sometimes poorly developed. Body is black, shiny. Mesonotum of the male with fairly long, projecting, light brown hairs; mesonotum of the female with very short hairs, almost bare. Wings transparent; in the female, as a rule, dark spots near the middle. Dorsum of the male abdomen dull black. 5-6 mm. European part of the USSR from the Leningrad Region to the Ukraine (Kiev, Khar'kov regions); western Europe. . . Ch. viduata L. 1758. Löw, 1843: 248; Lundbeck, 1916: 144; Sack, 1932: 38; Shtakel'berg, 1933: 230.

6 (5). Venter of the male abdomen, especially the second sternite, with long, projecting, light hairs. Mesonotum, scutellum and pleura of the female (in particular the mesopleura) with distinctly developed dense, semicontiguous or projecting light hairs. The median part of the dorsum of the male abdomen, as a rule, is dull black.

7 (8). Mesonotum and scutellum of the male with relatively long black (frontal view) hairs, the median frontal protuberance and the anterior edge of the mouth in the male protrude forward to the same degree and fairly strongly (Fig. 3,2). Mesonotum and scutellum of the female with short and dense, gold-colored, contiguous, hairs. Body and legs black; the median part of the dorsum of the abdomen dull. Gonocoxite (Fig. 1,4). Wings (Fig. 2,2) distinctly darkened at the middle. 6-8 mm. European part of the USSR from Arkhangel'sk Region to the Ukraine; the Caucasus (Gruziya); Siberia to Pribaikal'; all of western Europe. Usually on flowers. V-IX . . . Ch. macquarti Lw. 1943. Löw, 1843: 250; Lundbeck, 1916: 113; Sack, 1932: 37; Shtakel'berg, 1933: 231; Coe, 1953: 49.

8 (7). Mesonotum and scutellum of the male with relatively long, light (frontal view) hairs; the median frontal

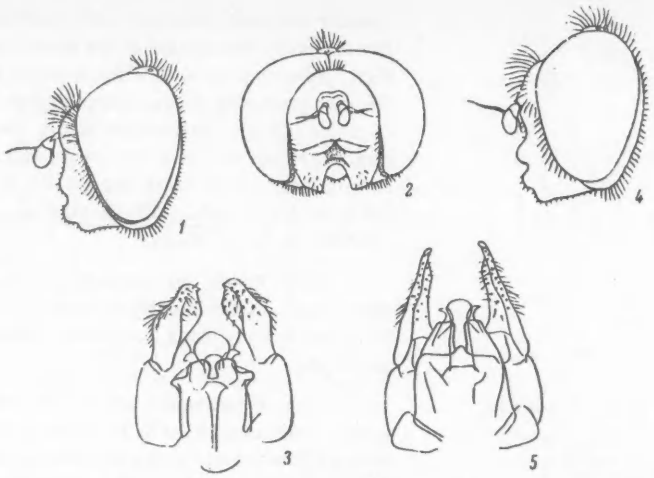

Fig. 4. 1) Chrysogaster tadzhikorum Stack., male, head in profile; 2) Ch. tadzhikorum Stack., male, frontal aspect of head; 3) Ch. tadzhikorum Stack., male, hypopygium; 4) Ch. kirgisorum Stack., male, head in profile; 5) Ch. kirgisorum Stack, male hypopygium. (After Shtakel'berg).

protuberance of the male protrudes forward somewhat less than the anterior edge of the mouth, the median frontal protuberance protruding forward less than in the preceding species (Fig. 1,2). Mesonotum and scutellum of the female with relatively long, projecting, light hairs.

9 (10). Squamae whitish, often with slightly yellow outer edges. Dorsum of the male abdomen dull black; the posterior margin of the second and third tergites, and also the entire fourth tergite except for the triangle on the anterior part, dark bronze, shiny metallic. The posterior abominal tergites of the female (in particular the fifth) with rather short semicontiguous, light hairs. Apical section m (= apical cross-vein) arranged more perpendicular to r_{4+5}, consequently the outer section r_{4+5} is relatively longer (Fig. 2,1). Body black; lateral margins of the abdomen with a bronze hue. Gonocoxite (Fig. 1,3). Legs black. Wings transparent or slightly darkened. 5-6 mm. Southeastern European part of the USSR (Saratov); Transcaucasus (Ordubad). V. . . Ch. tumescens Lw. 1873. Löw, 1873, Beschr. europ. Dipt., III: 214 (Orthoneura); Sack, 1932: 32 (Orthoneura).

10 (9). Squamae brown. The dorsum of the male abdomen, except for the lateral margins and the apical part, is dull black, including the posterior margin of the second and third tergites. The posterior tergites of the female abdomen (particularly the fifth) with rather long, projecting, light hairs. The apical section m (= apical transverse vein) is arranged more obliquely in relation to the longitudinal axis of the wing, consequently the apical section r_{4+5} is relatively short (Fig. 2,2). Body and legs black. Wings transparent or slightly darkened. 5-6.5 mm. Central and western Europe. V-VIII . . . Ch. hirtella Lw. 1843. Löw, 1843: 251; Verrall, 1901: 197; Collin, 1931, Entom. Month. Mag. 67: 157; Coe, 1953: 49.

11 (2). Base of the wings bright yellow. Body dark olive-green.

12 (13). Mesopleura bright shiny metallic; mesopleura and pteropleura with short, projecting, light hairs. Breadth of the vertex in the male, at the level of the antennal bases, is approximately equal to its height; the line of contiguity between the eyes is distinctly not as tall as the parietal triangle. Body dark olive-green. Frons in the male moderately broad, at the level of the antennal bases the eyes are somewhat narrowed, in profile the frons of the male with a quite prominent median protuberance; the edge of the mouth in the male protrudes strongly forward (significantly more than the median frontal protuberance).

14 (15). Vertex in the female moderately broad, eyes somewhat narrower (dorsal view), with course and dense punctures, with traces of transverse furrows. Vertex in both sexes shiny black; upper half of the frons greyish, densely pollinose. Mesonotum finely punctate, shiny, with relatively short, light, semicontiguous hairs.

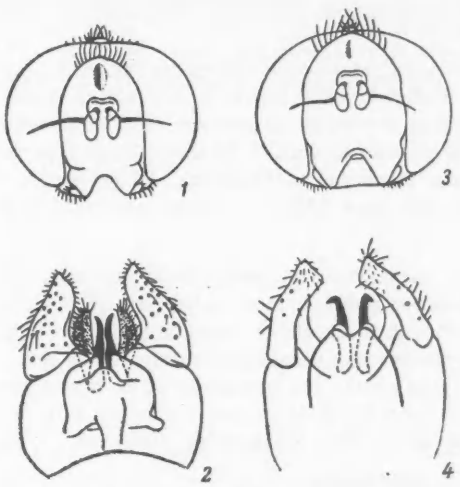

Fig. 5. 1) Chrysogaster musatovi Stack., male, head, frontal aspect; 2) Ch. musatovi Stack., male, hypopygium; 3) Ch. chalybeata Mg., male, head, frontal aspect; 4) Ch chalybeata Mg., male, hypopygium. (After Shtakel'berg).

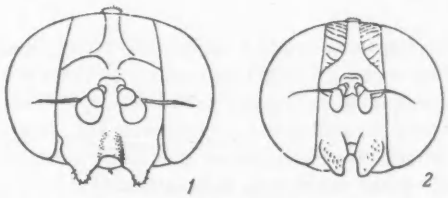

Fig. 6. 1) Chrysogaster sinensia Stack., female, head, frontal aspect; 2) Ch. solstitialis Fln., female, the same. (After Shtakel'berg).

Abdomen shiny on both venter and dorsum. 6-7 mm. Central zone of the European part of the USSR (Leningrad, Yaroslav, Perm' Regions). On flowers of rape, crowfoot, etc. . . Ch. jaroslavensis Stack. 1922 Shtakel'berg, 1922, Ezhegodn. Zoolog. myz. Akad. Nauk, 23: 363; Sack, 1932: 36; Shtakel'berg, 1933: 230.

13 (12). Mesopleura greyish, thinly pollinose, slightly shiny; mesopleura and pteropleura with relatively long, delicate, white hairs. Breadth of the male vertex at the level of the antennal bases 1½-2 times the height.

14 (15). Halteres yellowish brown or brown. Median frontal protuberance in the male weakly pronounced (Fig. 4,1). Frons in the male quite broad, distinctly widened toward the bottom (Fig. 4,2); frons and vertex in the male greyish, faintly pollinose; upper portion of the male vertex with black hairs. Mesonotum in the female with short light hairs; venter of the female abdomen metallic, shiny. Body dark olive-green, shiny. Legs black. Hypopygium (Fig. 4,3). 6-7 mm. Central Asia: Takzhikistan (Stalinabad, Hissar Range, Petr I Range), Uzbekistan (Katta-Kurgan Region). Mountains and foothills (800-2000 M). . . Ch. tadzhikorum Stack. 1952. Shtakel'berg, 1952: 363.

15 (14). Halteres light yellow. Median frontal protuberance well pronounced (Fig. 4,4); frons in the male quite narrow with nearly parallel borders; frons and vertex in the male greyish, distinctly pollinose; the entire expanse of the male vertex with light hairs. Mesonotum in the female with quite long, plumose, light hairs; venter of the female abdomen greyish, pollinose. Hypopygium (Fig. 4,5). The rest as in the preceding. 6-7 mm. Central Asia: Kirgiz (Frunze Region), southern Kazakhstan (Karatan Range). . . Ch. kirgisorum Stack. 1952. Shtakel'berg, 1952: 363.

16 (1). Antennae yellow.

17 (20). Wing bases light yellow; veins at the basal part of the wing yellow.

18 (19). The lower anterior part of the mesopleura (above and behind the front coxae) and hypopleura greyish, pollinose. Frons in the male quite broad (Fig. 5,3); edge of the mouth in the male barely raised. Aedeagus with well-separated distal processes (Fig. 5,4). A larger species: 6-8 mm. Body in the male brownish black, slightly shiny; mesonotum and pleura with moderately long, though not dense, dark hairs. Body in the female bluish black, shiny; mesonotum and pleura with very short, contiguous, dark hairs. Legs black. European part of the USSR from the Leningrad Region to the Ukraine; Caucasus and Transcaucasus (Erevan). A large part of western Europe. In the central zone of the European part of the USSR, usually in June-July on flowers of the Umbelliferae. . . Ch. chalybeata Mg. 1822. Löw, 1843: 241; Lundbeck, 1916: 118; Sack, 1932: 25; Shtakel'berg, 1933: 231.

19 (18). Mesopleura and hypopleura, over the entire expanse, black, shiny, not pollinose; a small grey pollinose spot present only on propleura directly above the bases of the front coxae. Frons in the male somewhat narrow (Fig. 5,1); edge of the mouth in the male distinctly raised. Aedeagus with distal processes close together (Fig. 5,2). A smaller species: 5-7 mm. Remaining characteristics similar to the preceding. Caucasus: Georgia (Teberda); Central Asia: Hissar Range (at elevations of 1000-2500 M). . . Ch. musatovi Stack. 1952. Shtakel'berg. 1952: 365.

20 (17). Wing bases brownish or transparent; veins at the basal part of the wing brown.

21 (24). Wings, at least in the apical part, distinctly darkened.

22 (23). The entire expanse of the wings darkened, dark brown. Mesonotum with course and dense, rasp-like punctures, shagreened, wrinkled, dark bronze, almost black, slightly shiny (female) or dull (male). Frons and vertex in the female significantly narrower (breadth of the frons at level of the antennae about equal to the breadth of the eye; Fig. 6,2). Legs black. Abdomen black, the median part dull. 7-8.5 mm. European part of the USSR from the LeningradRegion to the Ukraine (Kiev Region). Transcaucasus (Delizhan). A large part of western Europe . . . Ch. solstitialis Flln. 1817. Lundbeck, 1916: 116; Sack, 1932: 37; Shtakel'berg, 1933: 231; Coe, 1933: 49. coementeriorum F. 1775. Löw, 1843: 246.

23 (22). Wings darkened only on the apical third, brown. Mesonotum with sparse simple punctures, barely noticeably wrinkled, blue-black, steel-colored, very shiny. Frons and vertex, in the female, distinctly broader than the eye at the level of the antennal bases (Fig. 6,1). Head bluish-black, shiny; vertex in the female with barely marked transverse furrows. Antennae yellow. Thoracic pleura in the female black, with a bluish hue, shiny, with a small greyish pollinose spot above the base of the front coxae; the median part of the pleura (mesopleura, pteropleura) with very short, light hairs. Legs black. Abdomen bluish black, the median part dull. 7 mm. Western China: Sinkiang. Male unknown . . . Ch. sinensis Stack. 1952. Shtakel'berg, 1952: 366.

24 (21). Wings transparent or slightly, uniformly darkened, light-smoky.

25 (26). Sides of the female vertex with well developed, course transverse furrows; the edge of the mouth in the female protrudes forward slightly. Third antennal segment oval (its length somewhat exceeds its breadth), reddish, with a brown border at the apex; bristles on the upper surface of the second antennal segment longer and stronger. Body yellowish black. Mesonotum and scutellum with very short, dense, yellowish hairs. Squama whitish; halteres brown, with a rather light head. Fifth abdominal tergite in the female simple, without notches along the posterior edge. 7 mm. Central Europe. Male unknown . . . Ch. simplex Lw. 1843.* Löw, 1843: 243; Becker, 1921, Mitt. Zool. Mus. Berlin X: 19, 22; Sack, 1932: 37.

26 (25). Sides of the vertex in the female with poorly developed transverse furrows; the edge of the mouth in the female protrudes forward strongly. Third antennal segment round (its length does not exceed its width), entirely reddish yellow; bristles on the upper surface of the second antennal segment poorly developed. Body greenish black, shiny. Frons and vertex in the male about the same breadth as in Ch. chalybeata Mg., but the vertex is somewhat less protuberant; the median frontal protuberance is of insignificant size, but is quite pronounced, projecting forward about the same distance as the edge of the mouth (Fig. 3,4). Mesonotum and scutellum with very short yellowish brown hairs; thoracic pleura shiny, without greyish pollinose spots on the mesopleura. Squama brownish with a light fringe; halteres with a brown head. Abdomen greenish black, the median part dull; fifth abdominal tergite in the female simple, without notches along the posterior edge. 6.5-8 mm. Central Europe from Denmark to Austria. Redok . . . Ch. virescens Lw. 1854. Löw, 1854, Neue Beitr. II: 17; Verrall, 1901: 200; Lundbeck, 1916: 121; Coe, 1953: 50.

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*This species is not known to me in nature.

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REVISION OF THE PALEARCTIC SPECIES OF THE GENUS OECOTHEA HAL. (DIPTERA, HELOMYZIDAE)

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Zoological Institute, Academy of Sciences, USSR, Leningrad

The members of the genus Oecothea Hal. occur throughout the USSR from the Arctic to the deserts of Central Asia. They are found in both valleys and mountains as high as 4500 m above sea level in the eastern Pamirs. Throughout this expanse the species on which there are biological data are associated with rodent burrows. There the larvae develop and the imagos live. It is therefore possible that they have some epidemiological importance, but there have been as yet no investigations of this question. There are some reports in the foreign literature on encounters of Oecothea in burrows of other mammals and they will no doubt be discovered under these circumstances in the USSR also. In addition, several species of this genus have been collected in caves and at the windows of houses.

The absence of information on the structure of the male genitalia of Oecothea makes it difficult to use the works of both the older and many of the more recent authors. For this reason the literature up to Czerny (1924) could not be used in the present work (except for original descriptions). A total of eight species was known in the genus Oecothea, of which two were relegated to the synonymy; in the absence of the types it is not possible, critically, to evaluate this synonymy. Eleven species could be found in the territory of the USSR, of which eight are apparently new.

The types of all the new species are preserved in the collection of the Zoological Institute, AN SSSR, in Leningrad.

The author considers it his pleasant duty to thank A. A. Shtakel'berg for guiding the work.

Genus Oecothea Hal.

Haliday, 1839: 187 (subgenus); Löw, 1862: 128; Czerny, 1924: 88-89; Curran, 1926: 290; Czerny, 1927: 31; Czerny, 1928: 52-53; Curran, 1934: 379; Séguy, 1934: 336, Collart, 1948: 2.

Like the rest of the Helomyzidae, the members of the genus Oecothea have convergent postvertical bristles, well-developed vibrissae, and tibiae with anteapical spurs; the costa bears a row of spines outwardly and has a strong interruption before the confluence of the subcosta.

Medium sized flies (2.5-7.5 mm); coloration yellow to dark brown; dark colored forms usually have a lighter head, humeri, legs, and abdominal apex. Orbital seta single; one pair of vibrissae; third antennal segment rounded with an obtuse upper apical angle; arista very long with an extremely fine fringe* (Fig. 1); dorsocentral setae 1-3; prosternum bare; scutellar disc bare or setose. Anterior cross-vein(rm) situated behind the confluence of r_1 and the costa. Middle tibiae bearing medially 2-5 (usually 2) bristles on the anterior edge and 1-5 (usually 1) bristles on the posterior (Figs. 2, 3). Gonocoxites well developed, surstyli absent, cerci not merging. Gonite and metaphallic plate long, phallus strongly asymmetrical, often distinctly bent to the left.

The genus is distinguished from the other known Palearctic Helomyzidae by the presence of spines on the middle tibiae. It is so far the only character of a generic order, separating Oecothea from the related genus

*Several early authors did not notice this fringe.

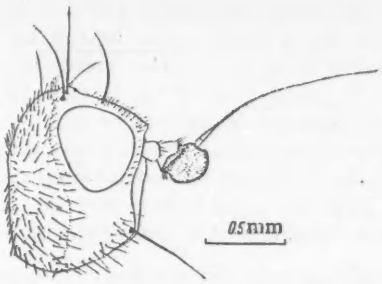


Fig. 1. Oecothea dubinini, sp. n., ♂, head.

Fig. 2. Oecothea dubinini, sp. n., ♂, middle tibia (anterior view).

Fig. 3. Oecothea aristata Mall., ♂, middle tibia (anterior view).

Eccoptomera Lw. There is a need for further investigations on the relationships of these two genera.

Type of the genus: Oecothea fenestralis Fall.

Systematic characters and structure of the terminalia. The faded, monotone, and uniform coloration of the body does not present good specific differences. In one species, Oe. fenestralis Fall., of which we had at our disposal a lot of material from different places, a considerable variation in coloration was observed.

Within the confines of the genus the chaetotaxy is constant and presents few characters, although some of them are convenient, such as the presence of setae on the disk of the scutellum.

The most suitable characters are provided by a study of the male genitalia, which have as yet been very little used [Curran, 1926: 290; Séguy, 1934: 214-216 (the illustrations of the latter author show several inaccuracies); Guibé, 1942 – in the related genus Eccoptomera], a particular advantage being the possibility of distinguishing very badly preserved specimens on the basis of the terminalia. Unfortunately the genitalia of the entire family Helomyzidae have been insufficiently studied. This compels us to present a description and illustrations of the structure of the abdomen using Oe. dubinini sp. n. as an example. Since the homologies of much of the structure of the ninth segment in the Cyclorrhapha are in dispute, the predominantly neutral terminology of Emden and Hennig (1956) is used, since this does not commit one to any particular comparative anatomical interpretation.

The abdomen of the male Oecothea consists of nine more or less well-developed segments. The anterior portion (the preabdomen) consists of five homonomous segments, although the first segment has a narrower tergite than the rest which is fused with the second, and its sternite is very greatly reduced; the postabdomen (Fig. 4) consists of four heteronomous segments. The sclerites of segments VI-VIII are strongly asymmetrical and almost all more or less reduced, such that it is possible to observe different stages of their oligomerization within the confines of the family; they are not completely stable even within the genus. The problem of the homology of the pregenital sclerites has been discussed by various authors, each of whom has his own opinions. A discussion of the literature on this problem may be found in Rubtsov (1951) and Steyskal, (1957). We will adhere to the interpretation of Crampton (1944) which, apparently, corresponds to what is observed in the Helomyzidae.

Sternites VI and VII are more stable than the tergites of the same segments; they are asymmetrical, shorter than the preceding ones, successively displaced to the left and of the same type in many genera, although the nature of their contiguity varies even in several species of Oecothea. Sternite VI is always separated from sternite V by a membrane, and from sternite VII by a suture or a membrane. The latter sternite

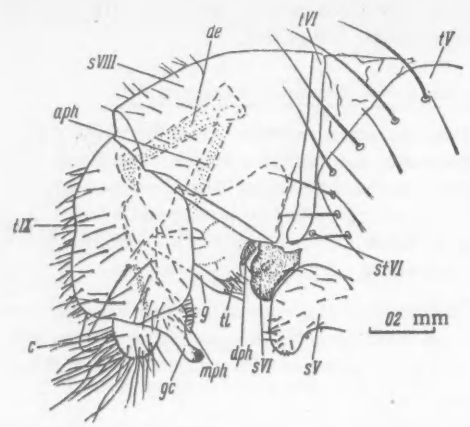


Fig. 4. Oecothea dubini, sp. n., apex of the male abdomen (lateral view): aph) apodeme of phallus; c) cerci; de) sclerite of ejaculatory duct; dph) distiphallus; fs) foramen of sternite IX; g) gonite; gc) gonocoxite; mph) metaphallic plate; s) sternite; st) stigma; t) tergite; tl) lateral tubercle.

(VII) in turn is separated from sternite VIII by a membrane, a narrow one to be sure (in Oe. dubinini, sp. n.), or by a suture (in Oe. aristata Mall.) which may disappear (in Oe. ushinskii, sp. n.); in the latter instance, nothing indicates the limits of the fused sclerites except for a few setae. In this manner the oligomerization of the sternites proceeds "before the very eyes." Often one or both sternites send outgrowths toward the middle of the ventral surface.

The reduction of the corresponding tergites has proceeded much further. In Orbellia cuniculorum R.-D. (det. Czerny) tergite VI does not differ from tergite V, but no traces of the following tergites could be found. In Neoleria prominens Beck. (Fig. 5) tergites VI and VII have been preserved, but in the form of narrow bands. The correctness of this interpretation of the sclerites is confirmed by the position of the two pairs of preserved stigmata. In the genus Oecothea the most primitive state of the pregenital tergites is observed in Oe. aristata Mall. (Fig. 6), in which tergite VI is preserved in the form of a ribbon-like sclerite surrounded by membrane. There are two pairs of stigmata belonging to segments VI and VII. Finally, the pregenital sclerite on the right side shows a suture which possibly delimits the rudiment of tergite VII. The further fate of tergite VI may vary, but its tendency toward oligomerization is unmistakable, either through fusion with the pregenital sclerite (Fig. 7) or as a result of its almost complete atrophy (Fig. 8).

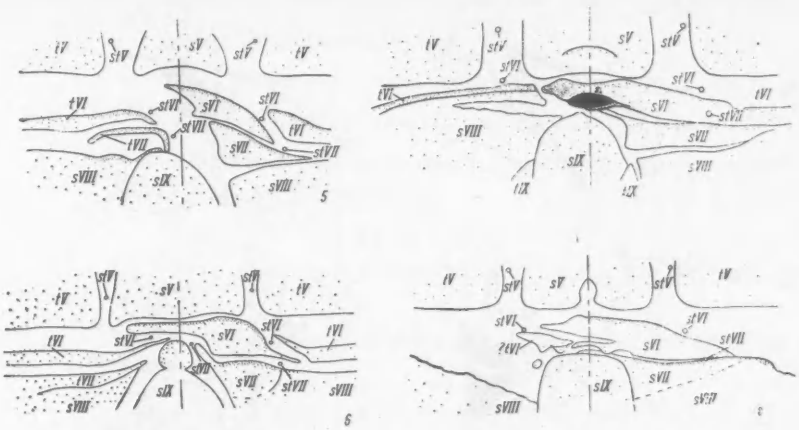
The most difficult and dubious question is that of the homology of the large posterior pregenital sclerite, the only one remaining of the eighth segment; however, nothing could be found which contradicted the opinion of Crampton that this is the sternite. We have already mentioned its fusion with sternite VII in several cases and, possibly, with the rudiments of tergite VII.

Tergite IX (the gonotergite or epandrium) forms a movable hood covering the gonosternite behind and below (Figs. 4, 9). On its lateral edge is articulated a pair of appendages — the gonocoxites * (coxites, styli, posterior surstyli, forceps inferior, valvulae laterales, etc.). In several species there are characteristic thickened and blunt spiniform setae (Fig. 10) on the inside at the apex of the gonocoxites. Cerci are attached posteriorly to the tergite (forceps superior, valvulae mediales). The inner part of the hood formed by tergite IX is lined with a membrane which in Oe. dubinini, sp. n., has an X-shaped thickening; the anterior arms of this cross and also two projections of the anterior margin of the tergite serve to articulate with sternite IX.

Sternite IX (the gonosternite or hypandrium) has a shape similar to a horseshoe (Figs. 11 and 12). In Oe. dubinini a suture runs across the front delimiting an asymmetric apodeme, strongly developed on the right side, which projects from the anterior end. Behind the suture the sternite shows an opening which in other species may be absent (for instance, in Oe. hamulifera, sp. n.) or may achieve considerable proportions, in which case it may almost completely separate the apodeme from the basal part of the sternite (for example, in Oe. acuta, sp. n.). Other sutures could not be found on the sternite. Posteriorly a pair of gonites (gonapophyses, parameres) is attached to the ends of the arc and is articulated in its turn with the apodeme of the phallus, the phallus proper, and the metaphallic plate (Fig. 13). The phallic apodeme forms an outgrowth in the middle ventrally which gradually, without any suture, becomes sternite IX. Paired lateral tubercles of the sternite are located anterior to the parameres.

The phallus (aedeagus, Figs. 12, 13 and 15) is divided into two sections: the stout, forwardly directed basiphallus and the always leftward-directed distiphallus, which is considerably more slender, at least at the base. In spite of its complicated structure, the phallus is not subdivided into separate sclerites and represents a single

*This term is employed provisionally, since the homology of the appendages with the terminalia still needs confirmation.



Figs. 5-8. Diagram of the structure of abdominal segments VI and VII in male Helomyzidae. The abdomen is cut along the dorsal midline and opened up. The axis is drawn along the middle of the venter. 6) Neoleria prominens Beck.; 6) Oecothea aristata Mall.; 7) Oe. dubinini, sp. n.; 8) Oe. dubia, sp. n. Abbreviations as in Fig. 4.

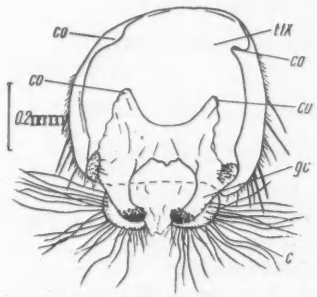


Fig. 9. Oecothea dubinini, sp. n., tergite IX of the male (anterior view); sternites VIII-IX removed: co) processes used for the articulation of sternite IX. Remaining abbreviations as in Fig. 4.

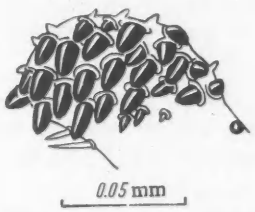


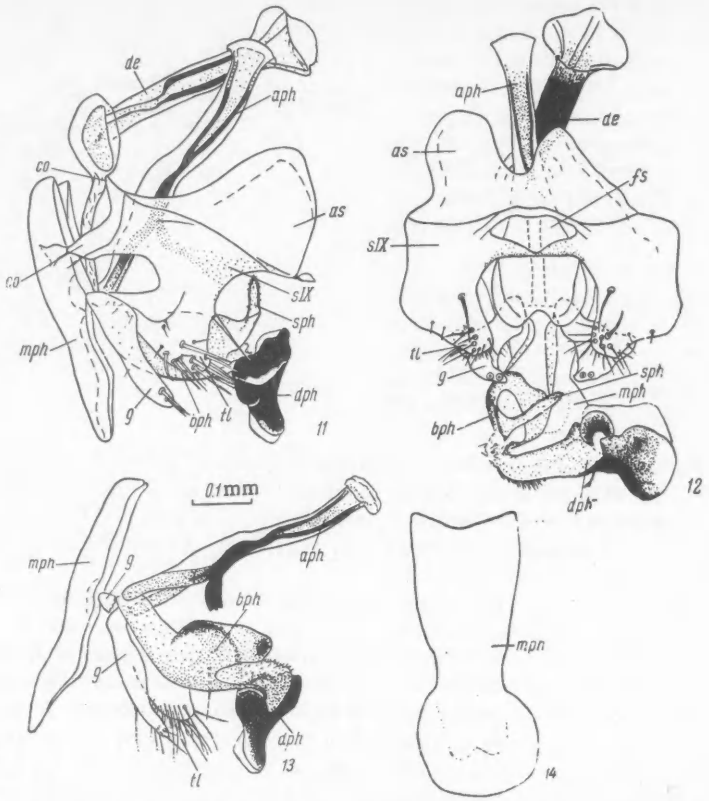
Fig. 10. Oecothea dubinini, sp. n., apex of gonocoxite.

formation. The basiphallus may bear a distal spine, while in Oe. dubia, sp. n., it has a pair of lamellate processes (analogous to the spinus titillatorius). The distiphallus is made up of two sclerotized bands at its proximal part (outgrowths of the basiphallic sclerite), between which there are membranous sections. It broadens at the apex and may form very complex, always asymmetrical structures; in Oe. hamulifera, sp. n., Oe. fenestralis and the closely related Oe. macrocerca, sp. n., and Oe. dubinini, sp. n., these consist of the broadened and bent apices of two sclerotized bands, which do not fuse together.

Behind the phallus there is a plate which is articulated with it, with the phallic apodeme, and with the gonites; we have called this plate the metaphallic plate (Fig. 14); its origin is not clear. Associated with the base of the phallus there is a structure usually called the sclerite of the ejaculatory duct.

In comparison with Leria and the group of genera which are close to Leria, the terminalia of Oecothea are characterized by the absence of surstyli, the considerably longer gonites and metaphallic plate, and the strongly asymmetrical phallus with its complex distal apex, but on the whole the general structural plan in all these genera is the same.

Evidently, most of the structures of the postabdomen and especially of segment IX may provide excellent systematic characters, at least for some of the species. The most convenient for separating the species are the shape and chaetotaxy of the gonocoxites, the lateral tubercles of segment IX, the gonites, and the metaphallic plate. Study of the structure of the phallus confirms the correctness of species separations. However, the structure of its distal part is very complex and its general appearance changes greatly with slight changes in the angle of vision. For this reason, even though the phallus provides excellent characters, it is not convenient to use it (without comparative material) and in the descriptions it is used only to a slight extent, especially as it does not introduce anything fundamentally new.



Figs. 11-14. Oecothea dubinini, sp. n., structure of sternite IX: 11) sternite IX isolated, in lateral view; 12) sternite IX isolated, in anterior view; 13) the same as Fig. 12 but with sternal plate almost completely removed (one left lateral tubercle remains) and with only the most proximal part of the right gonite remaining; 14) metaphallic plate isolated, in anterior view: as) apodeme of sternite IX; bph) basiphallus; sph) distal spine of the basiphallus. Remaining abbreviations as in Figs. 4 and 9.

Illustrations of the right gonocoxite and the gonite with its lateral tubercle are provided for each species. They are figured from the side, from a visual angle which is approximately perpendicular to the middle of the sclerite. The illustrations of the distal end of the metaphallic plate were made in anterior view, from a visual angle which is perpendicular to its plane. In all cases the genitalia were boiled in alkali and the same magnification of the microprojector was used for illustrating the species descriptions. All illustrations were made by the author.

The structure of the female genitalia is much less useful in the taxonomy. They are more uniform than the male terminalia,and their weaker sclerotization makes working with them more difficult. In several species no external differences could be found in the female genitalia. Finally, the females of several species are unknown.

The abdomen of the female consists of nine segments of which the first seven (except the first) are homonomous but gradually diminish posteriorly: sternite VIII is weakly sclerotized along the midline and is often of trapezoidal form; sternite IX is small, while tergite IX is preserved in Oe. aristata (Figs. 16-17) and is absent in Oe. fenestralis (Figs. 42-43).

Fig. 15. Oecothea dubinini, sp. n., apex of phallus (lateral view from left).

KEY TO THE SPECIES OF THE GENUS OECOTHEA HAL.

1 (10). Disk of scutellum setose.

2 (3). Height of eye equal to that of gena at middle . . . 11. Oe. praecox Lw.

3 (2). Height of eye distinctly greater than that of gena at middle.

4 (5). Cerci considerably (nearly 2 times) longer than gonocoxites. (Figs. 48 to 50). . . 7. Oe. macrocerca, sp. n.

5 (4). Cerci about as long as gonocoxites or shorter.

6 (7). Gonocoxites sharply widened at the base (Fig. 53). . . 8. Oe. dubinini, sp. n.

7 (6). Gonocoxites, if widened at the base, then only slightly and not sharply. (Figs. 34, 44, 45).

8 (9). Metaphallic plate ending in a point. (Fig. 47). . . 6. Oe. fenestralis Fall.

9 (8). Metaphallic plate rounded at apex. (Fig. 37). . . 4. Oe. ushinskii, sp. n.

10 (1). Disk of scutellum bare (except for 2 pairs of marginal bristles).

11 (12). Height of eye distinctly less than that of gena at middle. (Fig. 62). . . 10. Oe. longipes, sp. n.

12 (11). Height of eye not less than that of gena at middle.

13 (16). Metaphallic plate projecting beyond end of gonocoxites, considerably widened before apex. (Figs. 22, 27).

14 (15). Large species (total length more than 5 mm). . . 1. Oe. aristata Mall.

15 (14). Small species (total length less than 5 mm). . . 2. Oe. desertorum, sp. n.

16 (13). Metaphallic plate not projecting beyond ends of gonocoxites, if widened before the apex, then only slightly. (Figs. 33, 41, 58).

17 (18). Gonite bearing apically an inwardly directed hook-like process. (Figs. 39, 40). . . 5. Oe. hamulifera, sp. n.

18 (17). Gonite without process apically. (Figs. 31, 32, 56, 57).

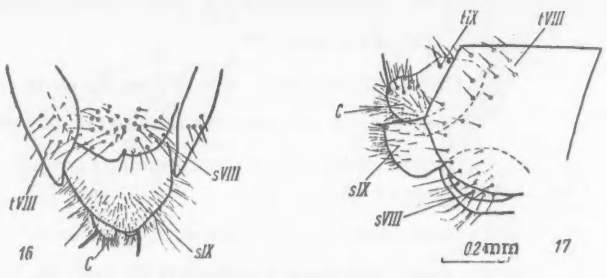
19 (20). Gonocoxite practically nor widened toward base. (Fig. 30). . . 3. Oe. acuta, sp. n.

20 (19). Gonocoxite considerably widened toward base. (Fig. 55). . . 9. Oe. dubia, sp. n.

1. Oecothea aristata Malloch (Figs. 3, 6, 16-17, 20-23, 63)

Malloch, 1919: 82c-83c; Johansen, 1921: 32k; Czerny, 1924: 89-90; Curran, 1926: 290; Weber, 1950: 201; Kapitonov, 1957: 1230 (Acantholeria sp.); Gorodkov, 1958: 949.

Male. Height of gena at middle half that of eye. Disk of scutellum bare. Bristles situated at base of middle femur below shorter than width of femur except for the slender, most proximal one. Middle tibia bearing anteriorly 2-5, rarely 6, bristles and posteriorly 3-5, their number sometimes varying on different sides of the same specimen. Tergite VI ribbon-like, separated before and behind by a membrane. On the right side a strip delimited by a suture along posterior margin of pregenital sclerite which may be a rudiment of tergite VII (Fig. 6). Sternite V flat, its posterior margin feetly sinuate. Sternite VI separated from sternite VII by a membrane and forming a lamina along almost entire edge of sternite V, not distinguishable in sclerotization from rest of sternite. Sternite VII partly fused with and partly separated by a suture from sternite VIII, forming a short lamina on the right side. Setae on sternite VIII and tergite IX feebly developed and equal in size. Length of tergite IX equal to its height. Gonocoxites small, in the form of slightly laterally flattened tubercles covered with coarse bristles and short spine-like bristles at apex. Cerci in the form of a T with a distorted upper stroke, equal in length to gonocoxites. Sternite IX bearing anteriorly a spherical capsule; opening of sternite in form of letter Y;



Figs. 16-17. Oecothea aristata Mall., apex of male abdomen: 16) ventral view; 17) lateral view. Abbreviations as in Fig. 4.

lateral tubercles feebly developed. Gonites saber-shaped, with two stout bristles posteriorly. Basiphallus dilated, proximally narrowing, bearing a large spine on the right distally and a small, dorsally directed one on the left. One forwardly directed cilia with a long fringe situated at bend of phallus. End of phallus moderately widened. Metaphallic plate very long, projecting beyond gonocoxites, its distal part slightly asymmetrical, its proximal end terminating in two forwardly directed outgrowths.

Total length 7 mm, length of wing 7.5 mm.

Female similar to male, but with fewer spines on anterior tibia: 2-4 anteriorly and 1-3 posteriorly. Rudiment of tergite IX preserved; sternite VIII short and broad.

This species has preserved the largest number of primitive characters. The structure of the female genitalia and the great length of the metaphallic plate bring this species lose to Oe. desertorum, sp. n., from which it is distinguished by the size of the body and by the almost symmetrical metaphallic plate.

Northern Yakutiya: 5 ♂♂ and 11 ♀♀, right bank of the Lena opposite Tit-Ary, July 30, 1957 (Gorodkov); 2♂♂ and 1 ♀, env. of Tiksi, Sevast'yan-Uryakh River, July 30, 1955 (Kapitonov); 1 ♂, 35 km S. of Tiksi, Lake Bolodin (Kapitonov); 2 ♀, 70 km S. of Tiksi, Khakhilia-Uryakh, middle course of the Kendei, August 26, 1956 (Kapitonov); 1 ♀, Verkhoyansk, June 15, 1913 (Mikhailov). All material, except the 1 ♀ from Verkhoyansk, collected in the burrows of Marmota camtschatica Pall. or near them.

This species was described from Arctic Canada; it had not been reported from Asia.

Kapitonov (1957: 1230) states that "marmot burrows are probably the only places where they can live." We also succeeded in collecting this species only in the burrows of the black-capped bobac at the entrance and at depth, observing the emergence of the imago from the puparium (2 ♀♀, puparia at the bottom of a burrow 10 cm from the entrance).

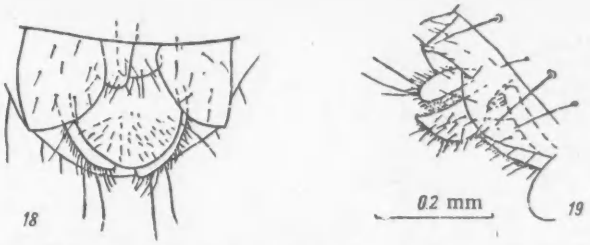
1a. Oecothea aristata pamirica Gorodkov, subsp. n. (Fig. 64)

Most of the specimens are distinguished by the almost round eyes, whereas in the Arctic subspecies the height of the eye considerably exceeds its width. Correspondingly, in Oe. a. pamirica the height of the gena is greater and is equal to the height of the eye. No differences in the genitalia could be found.

Holotype ♂ and allotype ♀: Pamir, Ak-Tash Pass (Pshart), 4320 m above sea level, nest and entrance of burrow of Marmota caudata Jacq., July 20, 1958 (Gorodkov). Paratypes: 5 ♂♂ and 12 ♀♀, same; 1 ♀, same, July 21, mowings in cryophyl meadow; 1 ♂, Gorno-Badakhshanskaya AR, middle course of the Balyandkiik, S. Kaindy River, 2 km SE of Kaindy Pass, 4200 m above sea level, August 13, 1958; 1 ♂, Pamir, Zulumart River, 3 km from confluence into Balyandkiik, 3900 m, steppe slope, August 8, 1958; 1 ♀, Pamir, 0.5 km N. of Akbaital Pass, 4500 m, bare talus, July 26, 1958. The latter three specimens were collected at the entrance of a burrow of Marmota caudata Jacq. (Gorodkov).

2. Oecothea desertorum Gorodkov, sp. n. (Figs. 18-19, 24-29)

Czerny, 1931: 19 (Oe. syriaca); Vlasov and Shtakel'berg, 1937: 286 (Oe. syriaca).



Figs. 18-19. Oecothea desertorum, sp. n., apex of male abdomen: 18) ventral view; 19) lateral view.

Male. Height of gena at middle half that of eye. Disk of scutellum bare. Middle femur below medially and proximally bearing 3-4 coarse bristles equal in length to width of tibia; one long slender bristle situated even closer to base. Middle tibia bearing anteriorly 2 bristles, posteriorly 1. Tergite VI very narrow, separated for almost its entire length by a membrane from sternite VIII, but dorsally merging with it. Sternite V flat, its hind edge almost straight. Sternite VI separated from VII by a suture; sternite VII fused with VIII. Sternite VI with a strongly sclerotized anterior edge which terminates somewhat posterior to the middle of sternite V. Sternite VII not forming any processes. Bristles of sternite VIII few in number and equal in size to bristles of tergite IX medially, larger along the edges. Length of tergite IX equal to its height. Gonocoxites represented by tubercles which are round in cross section and covered with sparse, slender bristles; no short spine-like bristles. Cerci laminate, equal in length to gonocoxites. Sternite IX bearing a capsule medially, its opening separating the apodeme anteriorly from rest of sternite; lateral tubercles feebly developed. Gonites long, slightly compressed apically, bearing anteriorly 2 bristles. Basiphallus dilated, proximally narrowing, distally on right side and medially bearing two dorsally directed outgrowths; distiphallus bearing anteriorly a glabrous outgrowth at the bend and posteriorly a plumose scale, its apex moderately broadened. Metaphallic plate very long, projecting beyond ends of gonocoxites, sharply asymmetrical at distal end, bearing a pair of forwardly directed outgrowths at proximal end.

Total length 2.75-3.75 mm, wing 3-4 mm.

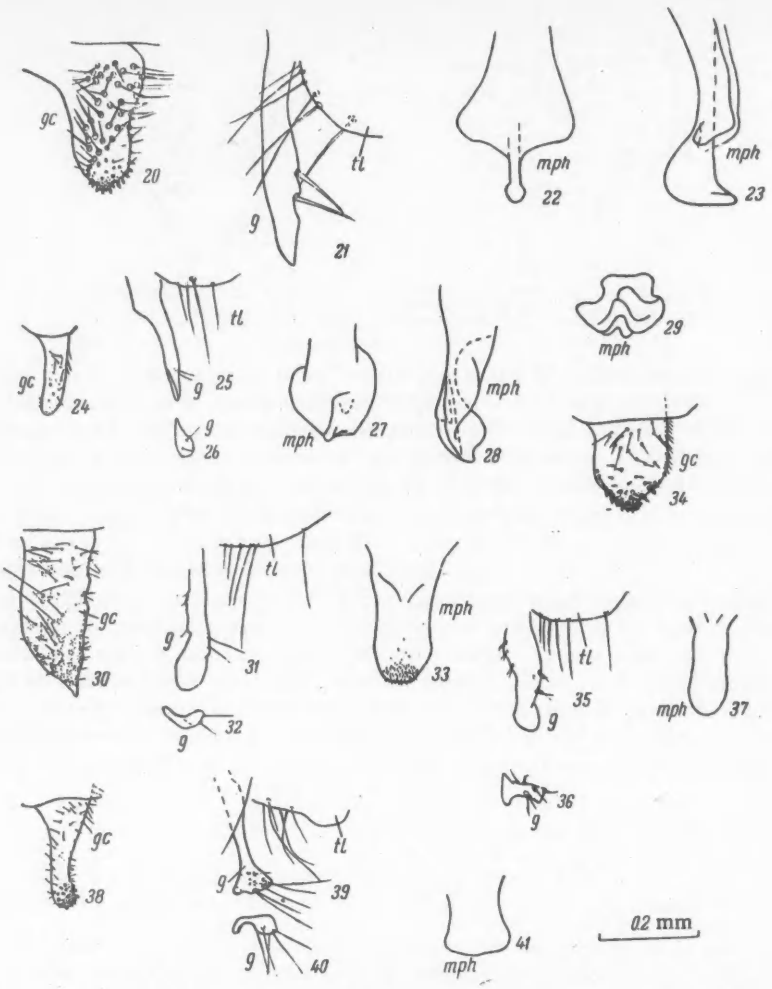
Female differing from male by the absence of long stout bristles ventrally on median femur. Sternite VIII membranous on midline, consisting of two narrow, moderately sclerotized bands bearing a few bristles distally.

The structure of the male genitalia and the great length of the metaphallic plate bring this species close to Oe. aristata Mall., from which it may be distinguished by its small size. The sharply asymmetrical metaphallic plate separates Oe. desertorum from all other members of the genus. Czerny (1931) considered this species to be identical to Oe. syriaca Vill., a fact which is however not yet demonstrated (see Oe. syriaca below).

Holotype: ♂, Turkmenia, env. of Ashkhabad, unconsolidated sand, on excavation of burrow of Spermophilopsis leptodactylus Licht.? February 25, 1930 (Vlasov). Allotype: ♀, between Ashkhabad and Ashkhabad River, from burrow of Rhombomys opimus Licht., November 29, 1930 (Vlasov). Paratypes: 14 ♂♂ and 10 ♀♀, env. of Ashkhabad, from burrows of Spermophilopsis leptodactylus Licht. and Rhombomys opimus Licht., various data (Vlasov). The above described material was determined by Czerny as Oe. syriaca Vill. 6 ♂♂ and 6 ♀♀, Ashkhabad District, under stones, April 20, 1933 (Petrishcheva); 1 ♂, 40 km N of Kizil-Arvat, Kara-Bogaz, April 30, 1953 (Granovskaya); 1 ♂, Uzbekistan, Bukhara, Baga-Absal, April 25, 1928 (Gerasimov).

3. Oecothea acuta Gorodkov, sp. n. (Figs. 30-33).

Male. Height of eye not less than that of gena of middle. Disk of scutellum bare. Only one slender bristle exceeding width of femur at basal portion of middle femur below. Middle tibia bearing anteriorly 2-3 bristles, posteriorly 1-2. Tergite VI separated by a membrane and represented by a very narrow band. Sternite V flat, its hind edge straight. Sternite VI separated from sternite VII by a suture and forming a narrow band which extends along almost all of sternite V. Sternite VII fused with sternite VIII, very short. Bristles on sternite VIII small, similar to those at middle of tergite IX, but setae along lateral edges of tergite IX larger. Height of tergite IX equal to its length. Gonocoxites in form of laminar lamellae covered with coarse bristles, the bristles shorter and coarser inwardly at apex; no short, stout, spine-like bristles. Cerci represented by lanceolate laminae, somewhat

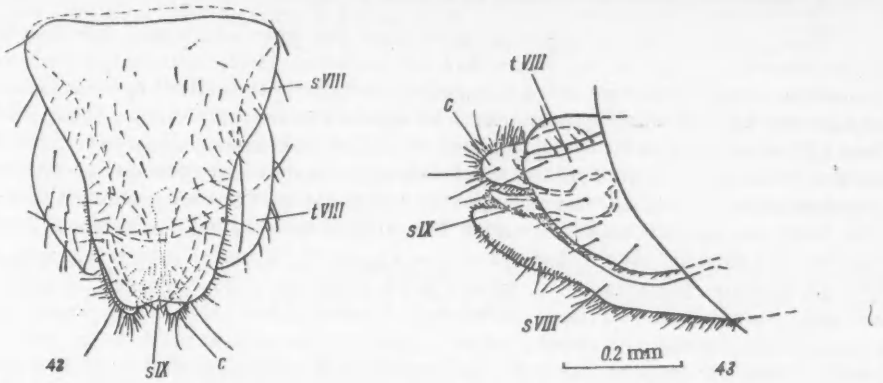


Figs. 20-41. 20-23) Oecothea arsitata Mall.; 23) metaphallic plate in lateral view); 24-29) Oecothea desertorum, sp. n., metaphallic plate in lateral view; [29) the same from apex]; 30-33) Oecothea acuta, sp. n.; 34-37) Oecothea ushinskii, sp. n.; 38 to 41) Oecothea hamulifera, sp. n. The right gonocoxite in lateral view, the gonite and lateral tubercle in lateral view (in several species the gonite is also figured in apical view), and the end of the metaphallic plate in anterior view are figured for each species. Abbreviations as in Fig. 4.

shorter than gonocoxites. Sternite IX bearing a capsule anteriorly; its opening very wide and separating apodeme from plate of sternite. Lateral tubercles not expressed. Gonites flattened and slightly hooked toward apex; bearing anteriorly 2 bristles and some minute ones posteriorly. Basiphallus dilated, narrowing toward base, bearing a dorsally directed plate near apex with a dentate edge. Two outgrowths at bend of distiphallus, of which the ventral is longest and both are fringed. End of phallus considerably widened. Metaphallic plate barely projecting beyond edge of tergite IX. Its distal end in the form of a lamina bearing a very fine fringe; the proximal end forming two forwardly directed outgrowths.

Total length 4 mm, wing 5 mm.

Female unknown.



Figs. 42-43. Oecothea fenestralis Fall., apex of male abdomen; 42) ventral view; 43) lateral view. Abbreviations as in Fig. 4.

This species is characterized by the acute apices of its gonocoxites, which are devoid of very short spine-like bristles.

Holotype: ♂, Kamchatka Region, Koryakskaya Kul'tbaza, Apuka, August 13, 1959 (Gorodkov). Paratypes: ♂, 18 km SE of Borovoe, Kazakh SSR, Koturkul', May 15-20, 1937 (Zimin). 1 ♂, Chitinsk Region, Borzinsk Dist., Kharanor, in Microtus brandti Radde burrow, August 13, 1958 (Grunin). In this specimen the gonocoxites are narrower than in the holotype, comparatively shorter, and consequently appear to be stouter, and the bristles on their inner side are coarser; it differs, although very little, in the structure of the end of the phallus.

4. Oecothea ushinskii Gorodkov, sp. n. (Figs. 34-37)

Male. Height of gena at middle considerably less than that of eye (as little as half). Disk of scutellum covered with bristles. Bristles at base of middle femur below shorter than width of femur. Middle tibia bearing 2 (rarely 3) bristles anteriorly and one posteriorly. Tergite VI in form of ribbon separated before and behind by a membrane. Sternite V bending dorsally at hind edge and bearing medially along edge several dense rows of short black bristles. Sternite VI separated from VII by a suture, with a sclerotized outgrowth extending to middle of ventral side under elevated edge of sternite V. Sternite VII fused with VIII. Bristles of sternite VIII and tergite IX feebly developed and approximately equal or somewhat larger in size on tergite IX. Tergite IX somewhat shorter than high. Gonocoxites laterally flattened, apically bearing very short and stout spine-like bristles on inner side and short coarse bristles on outer side. Cerci shorter than gonocoxites, with broad, obtuse ends. Sternite IX bearing anteriorly a median outgrowth; its entire anterior portion occupied by the opening. Lateral tubercles rounded, moderately developed. Gonites represented by lamellae which are hooked near the end, with larger bristles anteriorly. Basiphallus sharply bent in basal part, more distally with a slight excavation inwardly on ventral side; a small sclerotized process at base of distiphallus on right. A small leaf-like lamella with a long plumosity along edge issuing from area of bend. End of phallus moderately widened. End of metaphallic plate barely reaching edge of tergite IX in form of a stout and narrow lamina; proximal end terminating in two forwardly directed laminae.

Total length 4 mm, wing 5 mm.

Female unknown.

Separated from the species with bristles on the disk of the scutellum by the narrow, laminate metaphallic plate.

Holotype: ♂, Turkmenia, env. of Kara-Kala, shore of Sumbar, mowings, April 19, 1933 (Ushinskii). Paratypes: 1 ♂, Groznensk Region, 50 km N of Kizlyar, Tushilovka, bulrushes along shore of Novosel'naya River, May 12, 1921 (Ryabov); 1 ♂, Turkmenia, Chandyr' River valley, tributary of Sumbar, mowings, luxuriant vegetation of meadow type, April 23, 1933 (Ushinskii).

5. Oecothea hamulifera Gorodkov, sp. n. (Figs. 38-41)

Male. Height of gena at middle half that of eye. Disk of scutellum bare. Bristles at base of middle femur below, except for one slender one, shorter than width of femur. Middle tibia bearing 2 bristles anteriorly, 1-2 posteriorly. Tergite VI in form of ribbon, separated anteriorly and posteriorly by membrane. Sternite V flat, its hind edge with a median excision; sternite VI separated from sternite VII by a suture, the latter separated from VIII by a thinning of the chitin. Anterior edges of sternites forming strongly sclerotized bands. In addition, sternite VI forms a sclerotized plate which extends almost to right edge of sternite V. Bristles on sternite VIII very short, much shorter than those on tergite IX. Length of tergite IX considerably less than its height. Gonocoxites feebly and gradually broadening toward base, slightly flattened and a little bent in a lateral plane, covered with minute bristles and bearing short and very stout spine-like bristles on inner side at apex. Cerci in the form of laminae, shorter than gonocoxites. Sternite IX flat anteriorly, without an opening; lateral tubercles very low and long. Gonites slightly claviform and bearing a downwardly directed hook-like process and a tuft of bristles at end. Basiphallus slightly widened at middle, with a laminar tooth at end dorsally; bend of distiphallus bearing a very fine fringe on membrane. Sclerotized bands of distiphallus considerably separated for their entire length; expansion at end of distiphallus very feeble and not exceeding twice the width of phallus immediately after the bend. Metaphallic plate not projecting beyond edge of tergite, stout, slightly spatulate; its proximal end terminating in two forwardly directed processes.

Total length 5 mm, wing 6 mm.

Female unknown.

This species stands alone in the genus, being easily distinguished from the other members by the hook on the gonite and the feebly expanded end of the distiphallus.

Holotype: ♂, Transbaikal, Barguzinskie steppes, from nest of Siberian bobac, July to October, 1957 (Zarubina). Paratypes: 2 ♂♂, Minusinsk Dist., Monok, from suslik nests, to August 1, 1927 (Zverev).

6. Oecothea fenestralis Fallén (Figs. 42-43, 44-47).

Fallén, 1920: 5 (Helomyza); Haliday, 1839: 187 (Oecothea); Czerny, 1924: 90-91; Czerny, 1927: 31; Czerny, 1932: 29; Malloch, 1933: 181; Curran, 1934: 280, 281; Séguy, 1934: 314-316, 337; Wolf, 1935: 454; Vlasov and Shtakel'berg, 1937: 286; Nielsen, Ringdahl and Tuxen, 1954: 85; Shtakel'berg, 1958: 156.*

Type of the genus.

Height of gena at middle less than that of eye (as little as one half). Disk of scutellum covered with bristles. Bristles at base of middle tibia below shorter than width of femur (except for the one slender, most proximal one). Middle tibia bearing anteriorly 2-3 bristles, posteriorly 1. Tergite VI very narrow, sclerotized, dorsally fused with sternite VIII. Sternite V posteriorly slightly raised, the posterior edge forming a broad emargination. Sternites VI and VII separated from one another by a suture and partly by a membrane, and from sternite VIII by a thinning of the chitin. Near middle of sternite V sternite VI forms a strongly sclerotized tumosity approached by the lamina of sternite VII. Bristles of tergite IX shorter on central part, but usually somewhat exceeding bristles of sternite VIII in length, very short. Tergite IX somewhat longer than high. Gonocoxites short, compressed in a lateral plane, tapering toward apex in varying degrees. (Figs. 44-45 illustrate the extreme form), but distal end always wide, with several rows of short, stout spine-like bristles. Bristles along outer surface usually barely perceptible. Cerci in form of simple laminae, slightly exceeding the gonocoxites in length or shorter (down to ½ their length). Sternite IX flat anteriorly, with a rounded opening; lateral tubercles well developed, rounded. Gonites in form of lamellae, with 2 (rarely 3) forwardly directed bristles. Basiphallus dilated, narrowing toward base, bearing a long, horizontally and leftward directed spine on right side. Distiphallus consisting of two sclerotized bands broadening at end. A fine fringe at its bend. Metaphallic plate projecting beyond edge of tergite IX, its distal end bearing 2 slender laminae, often not evident; proximal end without processes.

Total length 2.5-5 mm, wing 3-5.5 mm.

Female similar to male. Sternite VIII long, trapezoidal.

*Only the most important literature is listed for this species.

This species is closely related to Oe. macrocera, sp. n. (there are no differences in the structure of the phallus) and Oe. dubinini, sp. n. (with slight differences in phallic structure). It is distinguished from the first by the small cerci, from the second by the absence of a sharp basal expansion of the gonocoxites.

The commonest and most widely distributed species of the genus Oecothea, although almost all the literature data needs confirmation. Found in Europe, Asia, and North America. Known from Iceland (Nielsen, Ringdahl and Tuxen, 1954: 85). Malloch (1933: 181, 184) records Oe. fenestralis from New Zealand and South America, believing that it may have been introduced by man. Becker and Stein (1913: 632) and Czerny (1932: 29) record Oe. fenestralis from Iran. The specimen to which these authors refer, from eastern Persia (collected by Zarudnyi), turned out to be a ♀ (!) of another species, from their determination labels.

Oe. fenestralis is apparently distributed throughout the USSR, this huge section of the range giving rise to considerable variation which, however, does not reach the level of specific differentiation. Dividing the species into subspecies would be premature.

Estonia (Shtakel'berg); Leningrad Region (Shtakel'berg, Pleske, Vagner, Gorodkov — Sablinskie Caves, October 20, 1957 etc.); 1 ♀, Yaroslav Region, Berditsino, June 2, 1907 (Yakovlev); 4 ♂♂ and 2 ♀♀. Michurin, on apple, May 14, 1957 (Pigarova); 4 ♂♂ and 4 ♀♀, Tsimlyansk Dist., burrow of water rat, June 9, 1936 (Lyubomirov); 1 ♂, Rostov-on-Don, May 8, 1924; 1 ♂, Stalingrad Region, Krasnoarmeisk, May 15, 1917 (N. Kuznetsov); 3 ♂♂, Orenburg Region, Sol'-Iletsk Dist., Mayak, July 24, August 21, 31, 1933 (Zimin); 1 ♂, Turkmenia, 100 km NE of Kizil-Arvat, Kirpili, sands, in Rhombomys opimus Licht. burrow, May 10, 1953 (Kir'yakova); 1 ♂, env. of Kara-Kala, April 17, 1933 (Ushinskii); many ♂♂ and ♀♀, env. Ashkhabad, from Spermophilopsis leptodactylus Licht. and Rhombomys opimus Licht. burrows, various dates (Vlasov); 1 ♂, Turkmenia, Iolotan', burrow, August 25, 1933 (Petrishcheva); 3 ♂♂ and 2 ♀♀, Tadzhikistan, Molotovabad, loess hills, at window, March 6-26, 1944 (Shtakel'berg); 1 ♂, Pamir, Zulumart River, 3 km from confluence of Balyandkiik, 3900 m above sea level, steppe-like slope, entrance of Marmota caudata Jacq. burrow, August 8, 1958 (Gorodkov); 1 ♂, Pamir, Murgab Dist., Chechekty, 3860 m, in house at window, June 11, 1958 (Gorodkov); 1 ♂, Altai, Uznezya on Katun', August 9, 1909 (Gorchakovskii); many ♂♂ and ♀♀, Yakutiya, from Citellus undulatus burrows (entrance zone), some specimens from pits in soil, June 18-19, 1957 (Gorodkov); 1 ♂, Chitinsk Region, Borzinsk Dist., Kharanor, in Microtus brandtii Radde burrow, July 13, 1958 (Grunin); 1 ♂, S.-Ussuri Territory, Sidemi, June 25, 1897 (Yankovskii); 1 ♂, Kamchatka, Klyuchi, May 6, 1933 (Koshkin); 1 ♂ Kamchatka, Karaga, July 11, 1930 (Novograblenov); 2 ♂♂ and 1 ♀, Chukotka, Providenie, July 16, September 9-12, 1948 (Maslov); 1 ♂, China, Kun'lun', Khuankhé basin, near Lake Orin-Nur, 4170 m, end of May- beginning of June, 1901 (Kozlov).

6a. Oecothea fenestralis Fall. f fidelis Curran.

Curran, 1926: 290-291 (Oe. fidelis); Czerny, 1928: 52 (Oe. fidelis); Gorodkov, 1958: 949.

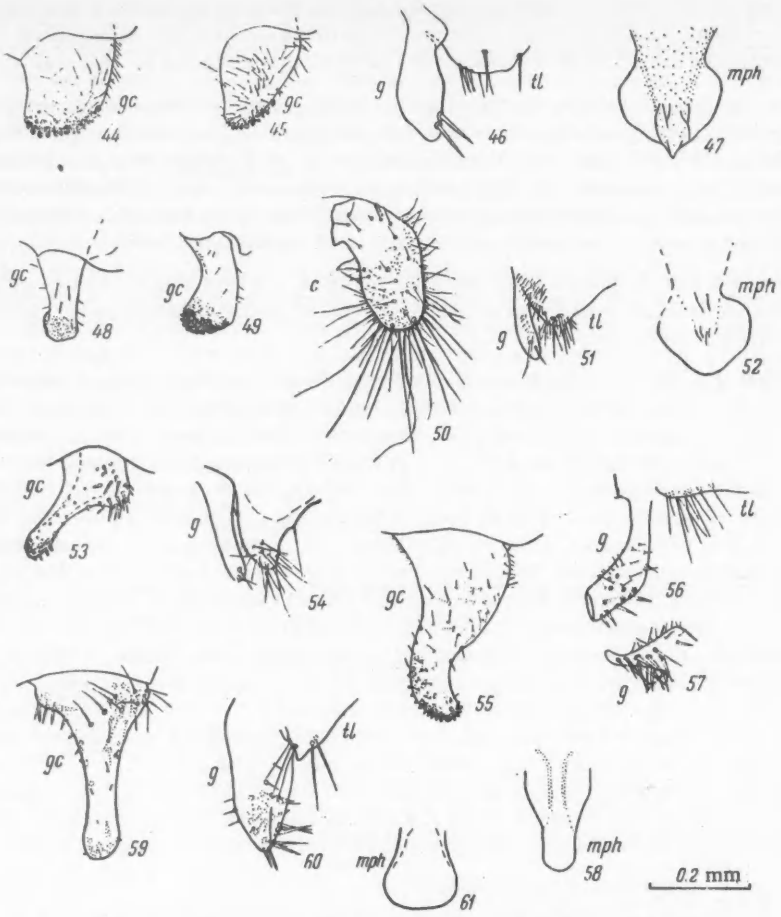
Described from Wrangel Island and distinguished by a dark spot on the anterior cross-vein, long fused cerci, coloration (described from preserved material!), and minor chaetotaxic characters.

Specimens of Oe. fenestralis from northern regions have a dark spot on the anterior crossvein (in southern specimens the darkening is less), the cerci are strongly approximated but not fused, as may be seen in preparations boiled in alkali; in the male the middle tibia bears 3-6 bristles anteriorly and 1-2 posteriorly; in females these are respectively 3 and 1. These specimens are probably identical to Oe. fidelis Curran which, therefore, is placed in the synonymy of Oe. fenestralis. Oe. fidelis Curr. does not exceed the limits of variation of Oe. fenestralis and could be either a northern subspecies of it, a population, or even a form which arises under the influence of low temperatures.

2 ♂♂, Novaya Zemlya, Matochkin Shar, Nochyev Creek, May 15 (slope of plateau) and July 18, 1925 (Bakulenko); Yakutiya: ? 1 ♂ (badly preserved), env. of Tiksi, Sevastyan-Uryakh R., in Marmota camtschatica Pall. burrow, July 30, 1956 (Kapitonov); 1 ♂ and 2 ♀, Chekurovka, lower Lena, July 23 and 24, 1958, in room at window (Gorodkov).

7. Oecothea macrocerca Gorodkov, sp. n. (Figs. 48-52)

Male. Height of gena at middle half that of eye. Disk of scutellum covered with bristles. Bristles at base of middle femur below considerably shorter than width of femur (except for the one slender, most proximal one). Middle tibia bearing anteriorly 2 setae, posteriorly 1. Tergite VI very narrow, sclerotized, dorsally fused with sternite VIII. Sternite V with a raised edge posteriorly which is medially excised. Sternites VI, VII and VIII



Figs. 44-61. 44-47) Oecothea fenestralis Fall.; 48-52) Oecothea macrocerca, sp. n.; [49 right gonocoxite in posterior view; 50) right cercus in posterior view]; 53-54) Oecothea dubinini, sp. n.; 55-58) Oecothea dubia, sp. n. (57; view of gonite from apex); 59-61) Oecothea longipes, sp. n. Right gonocoxite, lateral tubercle from side, and end of metaphallic plate from front are figured for each species. Abbreviations as in Fig. 4.

separated by membrane and suture. Sternite VI almost reaching right edge of sternite V, forming near its center a strongly sclerotized tumosity approached by the narrow process of sternite VII. Bristles of sternite VIII somewhat smaller than those of tergite IX. Length of tergite IX exceeding its height. Gonocoxites strongly bent inward, terminating in almost flat apex, covered with short and stout spine-like bristles. Cerci in form of wide laminae, very large, almost twice as long as gonocoxites. Sternite IX flat anteriorly; its opening rounded, the lateral tubercles high, the gonites strongly compressed and bearing apically two small bristles. Basiphallus dilated, narrowing toward the proximal end and distally bearing a spine which is directed to left; a fine fringe on distiphallus at bend, the end moderately broadened. Metaphallic plate long, projecting beyond the edge of tergite IX, not reaching ends of gonocoxites, distally membranous; no processes at proximal end.

Total length 3 mm, wing 3.5 mm.

Female unknown.

This species is very closely related to Oe. fenestralis, no differences in the structure of the phallus having been found. It is distinguished from all the other members of the genus by the very large cerci.

Holotype: ♂, Turkmenia, Farab, April 25, 1913 (Gol'bek), determined by Czerny as Oe. fenestralis. Paratypes: 1 ♂, Turkmenia, Bairam-Ali, February 27, 1913 (Smirnova); 2 ♂♂, env. of Samarkand, Agalyk, October 20, 1935, nest of Ellobius talpinus Pall. (Kirshenblat).

8. Oecothea dubinini Gorodkov, sp. n. (Figs. 1, 2, 4, 7, 9-15, 53-54)

Male. Height of gena at middle less than that of eye. Disk of scutellum covered with bristles. Bristles at base of middle femur below shorter than width of femur. Middle tibia bearing anteriorly 2-3 bristles, posteriorly 1. Tergite VI very narrow, sclerotized, dorsally fused with sternite VIII. Sternite V forming a cylindrical projection posteriorly, covered with spines. Sternites VI, VII and VIII separated by sutures and membranes, variously developed in different specimens. Sternite VI almost reaching right edge of sternite V, forming a strongly sclerotized tumosity near its middle which is approached by the narrow projection of sternite VII. Bristles on sternite VIII smaller than those on tergite IX. Length of tergite IX exceeding its height. Gonocoxites small, basally widened, laterally compressed and bearing bristles anteriorly and small teeth apically at the medial side (somewhat anteriorly). Width of cerci exceeding their length, these shorter than gonocoxites. Sternite IX anteriorly flat, its opening rounded, the lateral tubercles very high and narrow, the gonites moderately compressed and bearing anteriorly two small bristles. Basiphallus dilated, narrowing toward the proximal end and distally bearing a spine which is directed to left. A fine fringe on distiphallus at bend, its end moderately widened. Metaphallic plate of average length, somewhat projecting beyond edge of tergite IX, membranous at distal end; no processes at proximal end.

Total length 5 mm, wing 5.5 mm.

Female similar to male. Clear differences from the genitalia of Oe. fenestralis could not be found.

This species is closely related to Oe. fenestralis Fall. and Oe. macrocerca, sp. n., from which it is distinguished by the gonocoxites sharply narrowing toward the apex and the very prominent lateral tubercles; the strongly raised posterior edge of sternite V separates this species from the other members of the genus.

Holotype: ♂, Kapshil, 80 km S of Dauriya, June 8, 1943, in Siberian bobac burrow (Dubinin). Allotype: ♀, same. Paratypes: many ♂♂ and ♀♀, same; 1 ♂, Manok, Minusinsk District to August 1, 1927, from marmot burrow (Zverev).

9. Oecothera dubia Gorodkov, sp. n. (Figs. 8, 55-58)

Male. Height of gena at middle less than height of eye. Disk of scutellum bare. Middle femur basally with 5-7-8 coarse dark bristles below, these longer than width of femur. Middle tibia bearing anteriorly 2-3 bristles, posteriorly 1. Tergite VI atrophied; a small sclerite lying near seventh right stigma may be its rudiment (Fig. 8). Sternite V flat, its hind edge almost straight (in holotype) or with emargination (Fig. 8). Sternites VI, VII and VIII separated by sutures and thinning of the chitin. Sternite VI extending almost to right edge of sternite V while a process of VII extends to its center. Bristles of sternite VIII minute, much shorter than bristles of tergite IX. Tergite IX higher than long. Gonocoxites laterally flattened, basally widened, varying considerably in convexity of edges; very short and stout bristles at apex on inside. Cerci laminar and inwardly angulate, somewhat shorter than gonocoxites. Sternite IX flat in middle, without an opening, lateral tubercles feebly developed. Gonites in form of rather broad, bent laminae with numerous bristles on either side, larger on inner side. Basiphallus with a sharp bend in proximal part and bearing along sides one pair of lamellate processes, distally widening. Distiphallus issuing from it ventrally and curving left only very slightly, very weakly sclerotized at base, its end large and strongly sclerotized. Metaphallic plate in form of narrow lamina barely reaching edge of tergite IX; forming a pair of lamina at proximal end.

Total length 5 mm, wing 5.5-6 mm.

Female unknown.

In the structure of the pregenital sclerites this species is closest to Oe. longipes, sp. n., from which it differs in having larger eyes, weakly developed lateral tubercles, and narrower and more bent gonites.

Holotype: ♂, Turkmenia, Kara-Kala District, Arpaklenki River gorge, mountains, May 5, 1933 (Ushinskii). Paratypes: 1 ♂, same; 1 ♂, south Kazakhstan region, shore of Syr-Dar'ya, May 1, 1957 (Ler); 1 ♂, Tarbagatai, 2000 m above sea level, July 20, 1957 (Grunin).

Figs. 62-64. 62) Oecothea longipes, sp. n., ♂, head (lateral view, head slightly deformed); 63) Oecothea aristata Mall., ♂, head (view perpendicular to plane of gena); 64) Oecothea aristata pamirica, subsp. n., ♂, head (view perpendicular to plane of gena).

1 ♂, Bashkir ASSR, near Chishmy, Kuchumovo, June 13, 1908 (Sizov) is distinguished by smaller size (total length 3 mm, wing 3.75 mm), fewer long bristles on the middle tibia (3), narrower gonocoxites, and a number of other characters. The insufficiency of the material precludes an evaluation of the taxonomic significance of these differences.

10. Oecothea longipes Gorodkov, sp. n. (Figs. 59-62)

Male. Height of gena at middle greater than that of eye. Disk of scutellum bare. Middle femur basally with 5 bristles below which are equal in length to width of femur, the 4 distal ones stouter and black. Middle tibia bearing anteriorly 2-3 bristles and posteriorly 1. Tergite VI atrophied; a small sclerite lying near the seventh right stigma may be a rudiment of it. Sternite V flat, its hind edge straight, a wide, moderately sclerotized lamina of sternite VI extending along its entire length. Right edge of sternite VI feebly developed. A suture running along the border to sternites VI and VII, sternite VII fused with VIII, the border between them barely perceptible. Bristles on sternite VIII feebly developed and somewhat smaller than on tergite IX. Length of tergite IX somewhat less than its height. Gonocoxites large, laterally flattened, slightly inwardly bent, strongly widened at base, covered with coarse bristles and with stout spine-like bristles on inner side, especially at apex. Cerci almond-shaped, $^3/_4$ as long as gonocoxites. Sternite IX flat anteriorly, without any opening, but with a linear thinning of the chitin in its place. Lateral tubercles acute, gonites large, in form of broad, acuminate lamellae, with numerous bristles on inner side. Basiphallus sharply bent near base, more distally flat, with a short dorsal process at end on right. No appendages at bend of distiphallus; end of phallus moderately widened, extensively membranous. Metaphallic plate very short, not coming near edge of tergite IX, distal end widened and without membrane; 2 forwardly directed processes close to proximal end.

Total length 4 mm, length of wing 4.5 mm.

Female unknown.

In the structure of the pregenital sclerites this species is close to Oe. dubia, sp. n., from which it differs in the smaller size of the eyes, the well-developed lateral tubercles, and very wide gonites.

Holotype: ♂, Krasnodar District, Eisk, Experiment Station, on barley, June 5, 1926 (Shirokov).

11. Oecothea ? praecox Löw.

Löw, 1862: 128; Czerny, 1924: 91-92; Czerny, 1927: 31; Leruth, 1934: 104-105; Séguy, 1934: 337; Wolf, 1935: 454-455; Collin, 1943: 244-245.

According to the data in the literature, this species is distinguished essentially by the height of the eye, which is equal to that of the gena at middle, by the setose scutellum, and large size (5 mm). However, it is not impossible that a number of species may posess this set of characters, therefore one cannot be confident about the accuracy of the determination.

2 ♀♀, western Kazakhstan region, NW of Serebryakovo, May 9, 1951 (L. V. Arnol'di).

Somewhat larger than is indicated in the literature (7.5 mm), sternite VII in the form of the letter II with a strongly projecting transverse stroke.

Oecothea syriaca Villeneuve

Villeneuve, 1924: 8, Czerny, 1926: 54; Czerny, 1927: 31; Collart, 1948: 1.

This species is characterized by the bare scutellum, transparent wings, and 5-6 long black bristles at the base of the middle femur below. These characters are fairly well expressed in 3 species: Oe. dubia, sp. n., Oe. desertorum, sp. n., and Oe. longipes, sp. n. Czerny (1931: 19) considered Oe. desertorum, sp. n. to be Oe. syriaca Vill., but Oe. dubia, sp. n., most clearly shows the characters indicated by Villenueve. It is entirely possible that there exist still more species with these same characters. Only a study of the type could conclusively resolve this question.

Oecothea canadenis Garrett

Garrett, 1921: 129-130; Czerny, 1924: 90.

The only species of the genus not known in the Old World. There are no essential characters mentioned in the description which might enable one to gain an impression of what the species is.

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SPECIES OF THE GENUS LEUCOPIS MG. (DIPTERA, CHAMAEMYIIDAE) FROM THE CRIMEA

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On account of their biological peculiarities and their practical importance the flies of the genus Leucopis from the family Chamaemyiidae are of special interest. Leucopis larvae are carnivorous. They feed on aphids and coccids many of which are important pests of cultivated plants. In this connection the study of the biology and systematics of the species belonging to the genus Leucopis is particularly interesting.

The present article is the outcome of systematic and biological studies of the species of the genus Leucopis from material collected in southern and eastern Crimea. These studies were based primarily on the collections and observations of the author carried out in May-September 1957 in the neighborhood of Karadag Biological Station, in Old Crimea, Nikitsk Botanical Gardens, Simeiz and at Demerdzhi-Yaile, and also from the collections of L. A. Rubtsov made in 1949-1951 from Nikitsk Botanical Gardens and from Gurzuf.

METHODS

The adult insects were procured by sweeping in grass and on shrubs. From aphis colonies Leucopis was collected by means of an aspirator or with a small bag-net. Collections of eggs, larvae and puparia of the flies were made among the colonies of aphids and their galls and also from the ovisacs of scale insects. Besides this, puparia were collected from the soil and from litter on the ground. Larvae emerging from the eggs or collected in the field were bred in separate test tubes and fed upon sugar syrup. The effect of temporary hunger on the larvae and flies arising from them was experimentally examined. For determination of fertility dissections were made both on insects bred in the laboratory and on those caught in the field.

In the systematic treatment of the material special attention was given to the male genitalia which appeared to be a most important group of stable and distinctive characteristics. Preparations of the genitalia were made after maceration of the insect in 20% KOH. After maceration and washing the preparations were stained in acid fuchsin.

As a result of the work 9 species of the genus Leucopis were observed, of which 3 were new.

For the four already well-known species wer give new descriptions from the material collected in the Crimea. The types for the new species are found in the Zoological Institute, AN SSSR.

I am greatly indebted to the directors of the work, L. A. Rubtsov and A. A. Shtakel'berg, for their valuable advice of which I made repeated use, and to G. Kh. Shaposhnikov who produced the great work on the identification of aphids.

I also take advantage of a profitable opportunity to express my thanks to the workers association of the Karadag Biological Station, AN SSSR and to its director, A. N. Smirnov, and also to the workers in the plant protection section of the Nikitsk Botanical Gardens who rendered valuable halp in conducting the expeditionary work.

BIOLOGY

The species of Leucopis which we examined have many similar features in the biology of the imaginal phase, but according to the type of oviposition and the method of feeding of the larvae they fall into 3 distinct groups:

(I) The eggs are laid among colonies of unprotected species of aphids. The larvae crawl freely over plants searching for food. Pupation takes place on the plant or in the soil. To this group belong:

(1) Leucopis argenitcollis Zett.,

(2) Leucopis melanopus Tanasiichuk, sp. n.,

(3) Leucopis glyphinivora taurica Tanasiichuk, subsp. n.,

(4) Leucopis fumidilarva Tanasiichuk, sp. n.,

(5) Leucopis rufithorax Tanas.

(II) The eggs are laid in the galls produced by the aphids. The larvae feed on aphids inside the galls where pupation takes place. To this group belongs Leucopis palumbi Rd.

(III) The eggs are laid in the ovisacs of scale insects the contents of which are eaten by the larvae. Pupation also takes place under the cover of the ovisac. To this group belong two species of the subgenus Leucopomyia:

(1) Leucopis (Leucopomyia) silesiaca Egg.

(2) Leucopis (Leucopomyia) alticeps Czerny.

Hibernation of the species belonging to the first group takes place during the pupal phase on the stems of plants, in litter or in the soil at a depth of up to 5 cm. In spring the emergence of the fly was not observed. Under laboratory conditions diapause in the Crimean species ceased when the air temperature reached 18-20° (among individuals of L. glyphinivora and L. rufithorax from the Leningrad District – at temperatures of 17-18°). If pupation takes place in the soil the flies move toward the surface, vigorously separating the soil particles by means of the ptilinium. In the laboratory the flies sometimes escaped from the test tubes through the dense, cotton wool plug. As a rule the gonads of the emerging flies were undeveloped; the degree of underdevelopment varied and was directly related to the conditions of larval feeding.

Under the experimental conditions larvae of the 1st and 2nd instars, unfed for a period of 2-3 days but subsequently given food, or larvae of the 3rd instar pupating after 2-3 days starvation, produced flies with completely undeveloped ovaries. On the contrary, larvae maintained on a plentiful supply of food gave rise to flies with well-developed ovaries containing almost fully formed eggs. In connection with a protracted period of active life and development of the sexual products the adult flies need supplementary feeding. This is especially necessary for newly emerged flies which die if not fed within two days. An unusual method of feeding is the honey-dew secretion from aphids already described by us (Tanasiichuk, 1958).*

It should be noted that the flies do not feed solely on those species of aphids on which their larvae develop. For instance, from twigs of Spanish broom, which were covered by the bluish brown aphid, Aphis laburni Kalt., specimens of 5 separate species of Leucopis were collected at a time when the larvae of only two species were feeding on these aphids.

The daily cycle of Leucopis in the Crimea is different from that in the Leningrad District. According to field observations the flies are most active not only at midday, as in the north, but at 8-9 o'clock in the morning and 5-6 o'clock in the evening. In the heat of the day, when temperatures reach 32-35° in the shade, the flies prefer shady places and feed less actively.

Oviposition was observed only in L. melanopus. The eggs are laid on the leaves or the stalks of plants in the immediate vicinity of aphids. First of all, the fly carefully cleans the end of its abdomen with the hind tarsi. Then standing on all 6 legs, it adjusts the tip of the abdomen to the leaf, extending the posterior segments of the abdomen and within 2-3 seconds extrudes an egg. Oviposition is probably similar in the remaining species of this group.

On dissection no more than 4-5 fully formed, or very nearly mature, eggs were found in the female. On those rare occasions when oviposition occurred in the laboratory daily egg production did not exceed this figure. According to preliminary observations the total production of eggs reaches 50-60. Under laboratory conditions the flies live for up to 2 months; in nature probably longer.

*According to our observations the fly Physiphora demandata F. (Ulidiidae) obtains the secretion of the aphis, Aphis laburni Kalt. on the Spanish broom in the same way as Leucopid flies.

The eggs develop in 2-4 days. The emerging larvae crawl over the plants feeding on aphids. The method of feeding does not differ from that which we described for Leucopid larvae from the Leningrad District (Tanasiichuk, 1958).

The time occupied by the development of the larva is considerably shorter than that in the northern regions and, at temperatures of 24-26°, amounts to 5-6 days (in the Leningrad District at temperatures of 20-24°, it is 10-18 days).

As a rule, the larvae of L. melanopus, L. fumidilarva and L. rufithorax pupate in the ground at the end of the 3rd instar, when they become fully grown and fall from the plant. The larva of L. glyphinivora subsp. taurica pupate not only in the ground but also on plants, usually in well-protected places; for example, on Carduus pupation takes place in the flower heads at the bases of the leaves. On sage the puparia are found on the stems among the closely packed flowers. The larvae of species from apple, pear and Spanish broom generally pupate in the ground. The larvae of L. argenticollis Zett. pupates only on the leaves of reeds.

In these species the pupal phase occupies a period of 8-14 days (18-25 days in the north).

The species of this group pass through more than one generation a year. Because the oviposition period is drawn out and the developmental periods of the various generations overlap, the number of generations has not been established.

L. palumbi Rd. belongs to the second group. The eggs of this species are laid under the edges of the galls of the local pistachio aphid, Forda mordvilkoi CB (non Pass.) on the pistachio, Pistacia mutica. The time taken for the egg to develop has not been determined. The larve, after emergence, penetrate the gall and feed on the apterous forms of the aphid, often destroying all the aphids found there. The larvae develop over a period of 7-8 days and pupation takes place inside the galls. The pupal phase occupies a period of about 11 days but can extend to 14 days. The flies emerging from the puparia raise the edge of the galls by actively making of the ptilinium and so escape. However, galls containing dead flies were sometimes observed, the flies being unable to escape because of the hardening of the walls of the galls. The puparia were generally uniform in size – probably due to an abundance of food and the concealed life led by the larvae.

To the third group belong representatives of the subgenus Leucopomyia – L. silesiaca Egg. and L. alticeps Czerny.

The larvae of these species feed on coccids and mealy bugs.

Rubtsov (1954) quotes the following data on the biology of these species: the spring generation develops on Fillippia viburni Sign. in May-June; the second generation – from the second half of July and in August on Polvinaria pistaciae Bod. The eggs of Leucopis are laid in the ovaries of coccids and the larvae, after emergence, feed on the contained eggs. Larval development occupies 10-12 days. Pupation takes place under the covering of the ovisac and occupies little more than a week. Hibernation was not observed.

Identification Table for the Crimean Species of the Genus Leucopis

1 (14). Prescutal sclerite absent. (Subgenus Leucopis s. str.)

2 (13). Mesonotum grey or light grey.

3 (4). Antennae yellow . . . . . Leucopis grandis, sp. n.

4 (3). Antennae black

5 (6). Tibia yellow . . . . . Leucopis palumbi Rd.

6 (5). Tibia partially black.

7 (8). Base and tip of anterior tibia yellow . . . . . Leucopis argenicollis Zett.

8 (7). Tip of anterior tibia always black.

9 (10). Anterior tarsi completely black . . . . . Leucopis melanopus, sp. n.

10 (9). 1st joint of anterior tarsi half or wholly yellow.

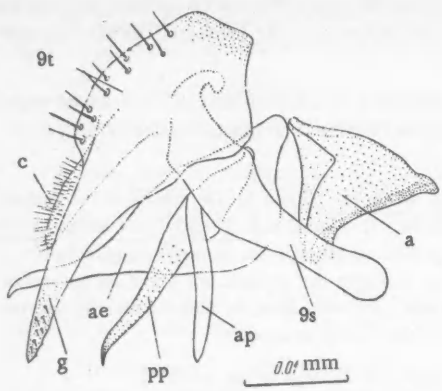

Fig. 1. Male genitalia of Leucopis grandis Tanasiichuk, sp. n.*

11 (12). Bristles on inner side of anterior femora short . . . . . Leucopis glyphinivora taurica, subsp. n.

12 (11). Bristles on inner side of anterior femora long . . . . . Leucopis fumidilarva, sp. n.

13 (2). Posterior half of mesonotum reddish gold . . . . . Leucopis rufithorax Tanas.

14 (1). A pair of prescutal sclerites present. (Subgenus Leucopomyia Czerny).

15 (16). Antennae yellow, tibia yellow . . . . . Leucopomyia silesiaca Egg.

16 (15). Antennae black, tibia black with yellow base . . . . . Leucopomyia alticeps Czerny.

Leucopis grandis Tanasiichuk, sp. n.

Male. Length of body 3.7 mm. Body light grey. Length of head in relation to width, 1.8 to 1. Width of frons at level of ocelli in relation to width of head, 1 to 2.3. Frons slightly dilating anteriorly. Eyes oval. Frontal area and lunule light grey. Antennae small, yellow. Base of antennae scarcely lower than middle of the head. Arista yellow with dark tips, 3rd joint of arista three times as long as 2nd. Length of gena 3 times less than length of eye. Proboscis and palps yellow.

Mesonotum grey. Lateral stripes absent, the median ones scarcely reaching the limit of the anterior third of the mesonotum. The mesonotum is covered with bristles except a small part at the base of the median strips. There are two pairs of dorsocentral bristles. Femora dark with yellow tips. Tibia yellow with dark ring in the middle. Tarsi yellow with black tips. Wings yellowish, the veins being light yellow. m and r_4+_5 slightly convergent. tr longer than last portion of cu and related to it as 4 to 3. Halteres yellowish. Abdomen grey. No spots on 2nd tergite but on 3rd tergite there are two symmetrical, round, black spots.

Genitalia. Male. (Fig. 1)**. Gonopophyses (g) long, gradually tapering to the tip, curved inward. At the end are 2-3 vague projections. Posterior end of 9th sternite (9s) sharply curved forward Aedeagus (ae) with wide basal portion. Cerci (c) narrow.

One male caught in Karadag, August 27, 1957 (holotype) on Spanish broom feeding on the aphid Aphis laburni Kalt.

Sharply differentiated by its size, external features and by the unique structure of the genitalia.

Leucopis palumbi Rd.

Male, female. Length of body 1.9-2.7 mm. Body light grey. Length of head in relation to its width, 1.6-1.7 to 1. Width of frons at level of ocelli in relation to width of head, 1 to 3. Frons slightly dilating toward the front, more so in the female than in the male. Eyes oval. Between the edges of the frons are two dark stripes which fuse below the ocelli. Base of antennae in the lower third of the head. Antennae black, base of arista yellow, 3rd joint of arista 2½-3 times as long as 2nd. Length of gena 4½ times less than the length of the eyes.

Proboscis reddish yellow, palps black.

Mesonotum grey. Reddish brown lateral stripes slightly spreading and extend almost to the posterior edge

*Symbols in Figs. 1-7.

a) apodeme of aedeagus
ae) aedeagus
ap) anterior paramere
c) cerci
g) gonopophysis
ls) lateral stripes
ms) median stripes
pp) posterior paramere
9s) 9th sternite
9t) 9th tergite

**In all the drawings of genitalia the gonopophyses, which are curved inward , are imagined to be straight.

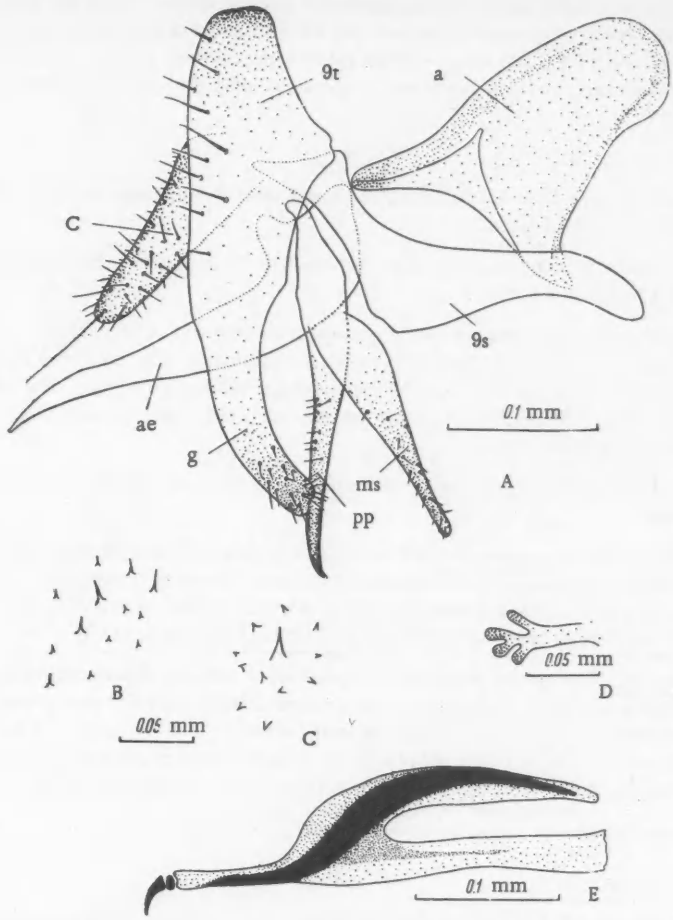

Fig. 2. Leucopis palumbi Rd: A) male genitalia; B) cuticular outgrowths on the 3rd-4th segments of the larva, dorsal side;* C) locomotory tubercle of 4th segment of larva; D) anterior spiracle of the larva; E) mouth-parts of larva.

of mesonotum. Brownish median stripes scarcely marked, often absent. Area between stripes free from bristles, at any rate as far as middle of mesonotum. There are two pairs of dorsocentral bristles.

Femora black. Tips of femora, tibia and tarsi yellow. Wing veins light brown. m and r_{4+5} converge quite strongly in their distal third. tr slightly curved and equal to the last portion of cu. Halteres white. 2nd abdominal tergite, with the exception of the posterior edge, occupied by a dark brown spot with a black border. On the 3rd tergite are two symmetrical, black spots; between them there is usually a black, longitudinal streak; the 4th and 5th tergites often have a streak also.

Genitalia. Male. (Fig. 2A). 9th tergite (9t) narrow, gonopophyses (g) long, with a wide end, turned inward 9th sternite (9s) with posterior end rising upward and expanding. Aedeagus (ae) long and tapering smoothly.

Larva. Larva with posterior spiracles clearly marked and widely spaced. Larvae which are feeding are rose-colored or reddish white with a yellow tinge. Their anterior end much lighter. Posterior spiracles white, semitransparent with reddish stigmata. Anterior spiracles (Fig. 2D) bear 4 digitate processes, the posterior have

*All the figures of larval parts are from larvae of the 3rd instar.

3 apertures. Cuticular outgrowths consist of long drawn-out pointed spines. These are especially well developed in rings encircling the anterior segments of the body but are also found on the abdominal walls. Locomotory tubercles of abdominal walls (Fig. 2C) bear 1-3 stout spines surrounded by groups of considerably smaller and shorter spines. Posterior spiracle also covered with long spines; only the very tip, which carries the stigmata, is free from them.

Mouthparts as in Fig. 2E.

Length of 1st instar larva up to 1.4-1.5 mm, 2nd instar larva 1.5-2.8 mm, 3rd instar larva before pupation up to 4-4.2 mm with a breadth of 1 mm.

Puparium. Puparium dirty brown, quite light, barrel-shaped. It preserves the chaetotaxy of the larva. Dimensions from 2.5 x 1 to 3.3 x 1.2 mm.

Biology. Solitary specimens were met with by sweeping at the end of May. Larvae and pupae were observed July 22nd in galls of Forda mordvilkoi CB (non Pass.) on pistachio. The flies were on the wing from July 24th-25th until the middle of August and could be found even at the end of August. The life of the larva is described above (page 830). The number of annual generations is not clear; probably more than one. The conditions for hibernation are also not clear.

The flies were observed feeding on the aphid Aphis laburni Kalt. on Spanish broom and on the nymphs of Psylla sp. on hawthorn.

Occurrence. We collected L. palumbi in Karadag and Nikitsk Botanical Gardens, but galls with empty puparia of this species were also observed in Simeiz and Alushta. Rodendorf (1940) reports the finding of L. palumbi in Uzbekistan in galls of the red pistachio aphis. Rondani (1874), in Palumbo (Sicily), bred L. palumbi from galls on Pistacia terebinthi, produced by Pemphigus (Geoica) utricularius Pass.

Systematic features. The species which we collected agree with the description of Rondani (1874), differing from it only in unimportant details. Thus, in the Crimean specimens, there are weakly marked median strips on the mesonotum (according to Rondani they are generally absent). The mesonotum of the Sicilian species, without exception, is covered with bristles, whereas in the Crimean species there are no bristles between the lateral and median stripes, at any rate, in the anterior portion of the mesonotum.

There are 51 specimens, males and females, in the 1957 collection.

Leucopis argenticollis Zett.

Male, female. Length of body 1.8-2.5 mm. Body light grey. Length of head in relation to its width, 1.5 to 1. Width of frons at level of ocelli in relation to the width of the head, 1 to 3. Frons dilates forward, generally insignificantly. Eyes oval. Frontal space silvery grey, the borders are the same color or slightly darker. Base of antennae situated below the middle of the head. Antennae black. Arista light yellow, its tip often dark. 3rd joint of arista 1.7-1.8 times longer than 2nd. Length of gena $4\frac{1}{2}$ times less than length of eye.

Proboscis yellow, palps black.

Mesonotum grey. Lateral stripes absent, median stripes weakly marked. Median stripes and places where lateral stripes should have been are covered with bristles, at least, as far as middle of mesonotum. There are two pairs of dorsocentral bristles.

Femora black with yellow tips. Tibia black, base and tip of tibia of front and middle legs yellow; on the hind leg only the base of the tibia is generally yellow. Tarsi yellow, sometimes with a darker tip.

On the wings m and r_{4+5} are parallel, tr is, at least, $1\frac{1}{2}$ times as short as distal portion of cu. 2nd abdominal tergite without spot. On each of 3rd, 4th and 5th tergites is a longitudinal, black line along the middle.

Male genitalia. (Fig. 3A). 9th tergite (9t) sturdy and wide, gonopophyses (g) tapering, slightly curved inward. 9th sternite (9s) very wide with sharp projections (the median ones, evidently, form the anterior parameres). Posterior paramere (pp) narrow, blade-like. Aedeagus (ae) small.

Egg. Egg white, elongated oval, surface ribbing narrow (Fig. 3C). Dimensions 0.5 x 0.16 mm.

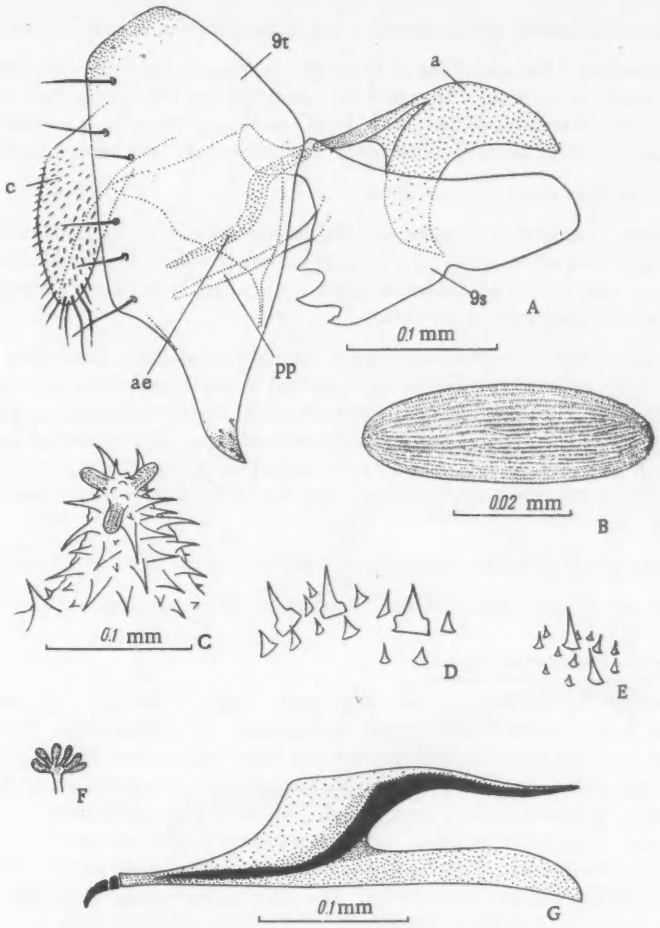

Fig. 3. Leucopis argenticollis Zett: A) male genitalia; B) egg; C) posterior spiracle of larva; D) anterior spiracle of larva; E) cuticular outgrowths (rings) of 1st segment of larva; F) locomotory tubercle of 6th segment of larva; G) larval mouthparts.

Larva. Larva widest in the posterior third and gradually tapering anteriorly. Posterior spiracles project very little and are not conspicuous. Recently emerged larvae are greenish. Larvae which are feeding are yellowish green and covered with a bloom looking like wax. Posterior spiracles dark. Anterior spiracles (Fig. 3D) each carry 6 digitate processes and each of the posterior spiracles bear three apertures. Encircling the first three segments are clearly marked rings of sharp cuticular outgrowths on wide cylindrical bases (Fig. 3E). The large spines are encircled by much smaller ones. The largest are situated along the sides of the body. On the following segments these rings are smoothed off but they are evident on the sides. On the abdominal side of the 4th to 10th segments there are transverse ridges with a pair of tubercles continuing laterally into a pair of locomotory tubercles on each side. The tubercles are armed with a few stout spines encircled by smaller ones (Fig. 3F). The dorsal side is set with stout spines arranged in a confused manner. Posterior spiracles covered with large and small spines (Fig. 3C). Mouthparts as in Fig. 3G.

Length of newly emerged larva 0.8-0.9 mm, 2nd instar larva 1.5-2.8 mm, 3rd instar larva before pupation up to 4.5 mm with a breadth of 0.8-0.9 mm.

Puparium. Puparium strongly depressed, reddish-brown, covered with a thin, waxy bloom which makes it appear ashy grey. Cuticular outgrowths of larva are preserved. Dimensions from 3 x 1 to 3.5 x 1.3 mm.

Biology. Eggs and larvae were collected in Nikitsk Botanical Gardens July 2nd-4th.

In Karadag isolated specimens were collected by sweeping from August 3rd-September 20th.

Eggs are laid on leaves of the reed Phragmites communis among colonies of the aphid Hyalopterus arundinis F. The eggs develop in about two days. The larvae feed on aphids and are more active than the larvae of other species of Leucopis. The development of the larva takes 4-5 days. Pupation takes place on the leaves of the reed, the puparium being securely fastened to the leaf. The pupal phase lasts about 8 days.

The number of annual generations is not clear.

Systematic features. Our specimens agree with the description of L. argenticollis from Czerny (1936). The sole difference is the color of the arista (according to Czerny it is dark, in our specimens it is yellow). This characteristic is not very constant and taking into account the conformity of all the other characteristics it is quite possible to explain the geographical variability.

This species is closely related to Leucopis apicalis described by Malloch (1914) from the island of Taiwan. There are differences in the color of the antennae and legs and in the length of the gena. Hennig (1938) gives a drawing of the genitalia of L. apicalis which, in general outline, closely resembles the genitalia of L. argenticollis but differs in the structure of the 9th sternite and aedeagus. In a number of genitalia characteristics (excessive diminution of aedeagus, strongly modified parameres) and in the morphology of the larva and puparium it differs from the representative of the subgenus Leucopis s. str. It would seem to be best to isolate this species in a separate subgenus.

In the Crimea this species is found, up to now, only in Karadag and in Nikitsk Botanical Gardens.

Altogether, there are 20 specimens, males and females, in the collections.

Leucopis melanopus Tanasiichuk, sp. n.

Male, female. Length of body 1.7-2.4 mm. Body grey. Length of head in comparison with its width, 1.5-1.6 to 1. Width of frons at the level of the ocelli in relation to the width of head, 1 to 2.5. Frons does not contrast forward. Eyes oval. Between the light edges of the frons there are two dark stripes surrounding the ocelli, partially fusing above the lunule. Base of antennae situated on the edge of the lower third of the head. Antennae black, 3rd joint of arista 3 times as long as 2nd. Length of gena 3.8-4 times less than length of eye. Proboscis brown, palps black. Mesonotum grey, the posterior part and the shield inclining to reddish. Lateral stripes reddish brown, reaching almost to the hind edge of mesonotum; median stripes only a little shorter than the lateral. Spaces between stripes free from bristles. Two pairs of dorsocentral bristles.

Fore legs entirely black. Tips of femora and bases of tibia of middle and hind legs yellow. 1st and 2nd joints of tarsi of middle legs either half yellow or yellow only at the base. Wing veins light brown. m and r_{4+5} converging in the upper third. The slightly bent tr $^1/_4$-$^1/_5$ shorter than the apical portion of cu. Halteres yellowish. 2nd abdominal tergite almost wholly occupied by a large brown spot. On 3rd tergite are 2 symmetrical black spots. On each of the 3rd, 4th and 5th tergites, along the middle, is a light longitudinal streak which may be absent.

Male genitalia (Fig. 4A). Gonopophyses (g) massive, fairly wide, their ends turning inward. At the end of the gonopophysis is one stout tooth. 9th sternite (9s), with a bulge almost in the middle, tapers anteriorly and turns smoothly upward. Aedeagus (ae) has a massive basal portion sharply curving upward.

Egg. Egg white with wide surface ridges (Fig. 4B). Dimensions 0.50-0.52 x 0.17-0.18 mm.

Larva. The usual form of larva with widely situated, horn-like, posterior spiracles. The newly emerged larva is greenish, but the larva which is feeding is greenish yellow with the alimentary canal shining through the cuticle. A grey, discontinuous stripe is seen along the back in the posterior half of the body. Posterior spiracle dark brown, stigmata light. Each anterior spiracle carries 4 digitate processes (Fig. 4E), the posterior spiracles each bear 3 apertures. Rings of sturdy conical spines, with round bases and encircled by much smaller spines, are clearly seen around the first three segments (Fig. 4C). These spines are stoutest on the sides. On the following segments the rings are less strongly developed. From 4th-10th segments, on the abdominal wall, are transverse ridges each bearing small paired tubercles and two pairs of locomotory tubercles (Fig. 4D) on the side of the

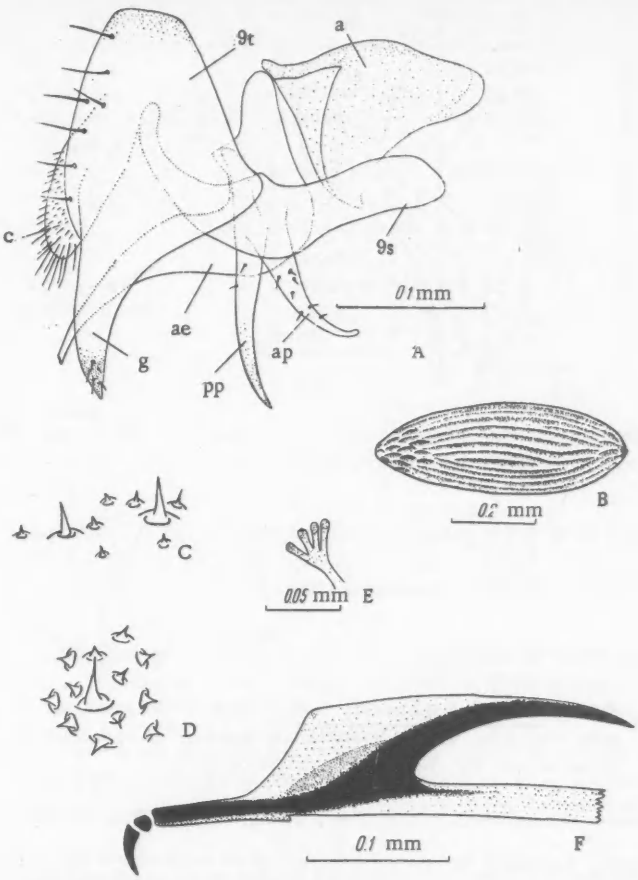

Fig. 4. Leucopis melanopus Tanasiichuk, sp. n.: A) male genitalia; B) egg; C) cuticular outgrowths of rings of 2nd segment of larva; D) locomotory tubercle of 5th segment of larva; E) anterior spiracle of larva; F) mouthparts of larva.

ridge. Spines are located on both ridges and tubercles. On the dorsal side there are small spines slightly varying in size. Two thirds of the posterior spiracles are covered with spines diminishing in size in the direction of the stigma. Mouthparts as in Fig. 4F.

Length of newly emerged larva 0.8-0.9 mm, of 2nd instar larva 1.5-2.5 mm, of 3rd instar larva before pupation up to 4 mm by 1.1 mm wide.

Puparium. Puparium reddish brown, barrel-shaped, preserving the chaetotaxy of the larva. Dimensions from 2.5 x 1 to 3 x 1.2 mm.

Biology. The flies are encountered throughout the season from May 26 to Sept. 23. The eggs, larvae and puparia from June 4 to Sept. 11 almost without interruption.

The eggs are laid on twigs and leaves of Lactua viminea among colonies of the aphid Dactynotus sp. The egg develops in 3-4 days. The duration of larval development is about 5 days in June and 7-8 in September. The larva pupates in the soil at a depth of 3-5 cm. The pupal phase occupies 12-14 days in June and 16-17 days in September. There are a few generations a year (not less than two). In addition to the secretion of Dactynotus the imago also feeds on the secretions of the aphids Brachycaudus cardui L. on Carduus, Aphis laburni Kalt. on Spanish broom, Myzodes persicae Sulz. on henbane and on aphids from sage.

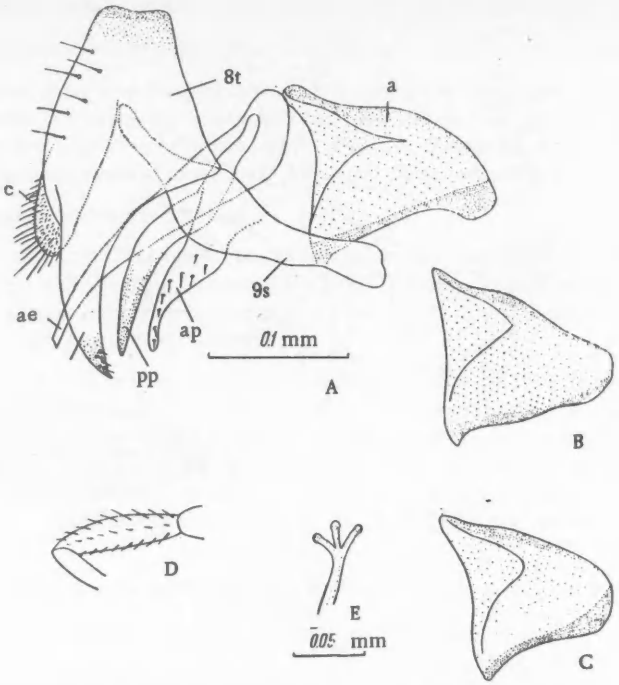

Fig. 5. Leucopis glyphinivora taurica Tanasiichuk, subsp. n.: A) male genitalia; B and C) variation in apodeme of aedeagus; D) femur of fore leg; E) anterior spiracle of larva.

Occurrence. Almost all specimens collected in Karadag, only one from Alushta.

Systematic features. According to external, morphological characters it resembles L. atritarsus Tanas. but the base of the tarsus of the fore leg is not always yellow. The genitalia is noticeably different in the width of the gonopophysis as well as in the shape of the aedeagus and the 9th sternite.

Holotype: male, July 29, 1957, Karadag.

In all collections 82 specimens, males and females.

Leucopis glyphinivora taurica Tanasiichuk, subsp. n.

The species described is from the Leningrad District (Tanasiichuk, 1958) under the name of Leucopis glyphinivorus.

The Crimean subspecies differs by the following features in the structure of the genitalia and larval morphology:

L. glyphinivora s. str.	subsp. taurica
In the male genitalia the 9th tergite is very wide, gonopophysis wide and short.	In the male genitalia (Fig. 5A) 9th tergite (9t) is much narrower, gonopophysis (g) longer and narrower.
Posterior portion of 9th sternite curved slightly upward.	9th sternite (9s) almost straight.
Anterior spiracles of larva have 5 digitate processes.	Anterior spiracles of larva have 3 digitate processes (Fig. 5E).

Aphid	Plant	Place	Time	Notes
Undetermined	Sage	Karadag	16 VI-30 VII	Mass collections
Aphis pomi De Geer.	Apple	Old Crimea	18 VI	Single collection
Aphis grossulariae Koch.	Gooseberry x Currant hybrid	Karadag	26 VII	Same
Dysaphis reaumuri Mordv.	Pear	Karadag	Throughout August	Mass collections
Brachycaudus cardui L.	Carduus.	Karadag, Nikitsk Gardens	26 VI-15 VIII	Same
Undetermined	Lappa.	Demerdzhi-Yaila	5 VII	Single collection
Aphis laburni Kalt.	Spanish broom	Karadag	Beginning of July to end of September	Solitary specimens

The subspecies is very variable in color-lateral stripes of mesonotum vary from reddish brown to golden red and also vary in width and length: median stripes sometimes almost indiscernible. The color of the tarsi also varies, but to a lesser degree.

In the male genitalia the width of the gonopophysis changes and also the shape of the apodeme (a). Exteriorly, the imago is very like L. fumidilarva, differing only by the much shorter bristles on the outer side of the anterior femur (Fig. 5D). Nevertheless, the male genitalia is entirely dissimilar and the larval morphology is also different.

Biology. This is the species most often met with. It is found throughout the whole season from June 26th to September 29th by sweeping. Eggs and larvae were observed at different times among colonies of certain species of aphids (see table).

The feeding of the adult insects was observed on almost all these aphids. In addition to this, at the end of May and the beginning of June, flies were caught feeding on the secretions of the nymphs of Psylla sp. on olivaeform pear and hawthorn, but in September on the aphid Dactynotus sp. on Lactuca viminea and on Myzodes persicae Sulz. on henbane.

The egg takes 2-4 days to develop. At an average temperature of 24-25° the larva develops in 4-5 days. The duration of the pupal phase is 9-10 days.

In the course of the year there are no less than 3 generations, the summer ones following one on another due to the very protracted oviposition period. The larva pupates both on plants (for example, in flower heads and leaf bases of Carduus, among the inflorescences of the sage) and in the soil. It hibernates in the pupal phase, generally in the soil.

Occurrence. Karadag, Old Crimea, Alushta, Demerdzhi-Yaila, Nikitsk Botanical Gardens.

Holotype of subspecies; male, July 1, 1957, Karadag.

In all collections about 200 specimens, males and females.

Leucopis fumidilarva Tanasiichuk, sp. n.

Male, female. Length of body 1.4-2.3 mm. Body light grey. Length of head in relation to its breadth, 1.6-1.8 to 1. Breadth of frons at level of ocelli in comparison with width of head, 1 to 2.4 in the male and 1 to 2.5 in the female. Eyes oval, contracted downward. Two dark stripes on the frons passing round the ocelli. Base of antennae situated a little lower than the middle of the head. Antennae black. 3rd joint of arista 3 times as long as 2nd. Length of gena 3.5-3.7 times less than the length of head. Proboscis yellow, palps black.

Mesonotum light grey. The reddish brown lateral stripes reach almost to the posterior edge of the mesonotum. The dark median stripes almost as long as the lateral. The spaces between the stripes free from bristles. There are 2 pairs of dorsocentral bristles.

Legs black. Tips of femora and bases of tibia yellow. 1st joint of tarsi of fore leg half, or entirely yellow

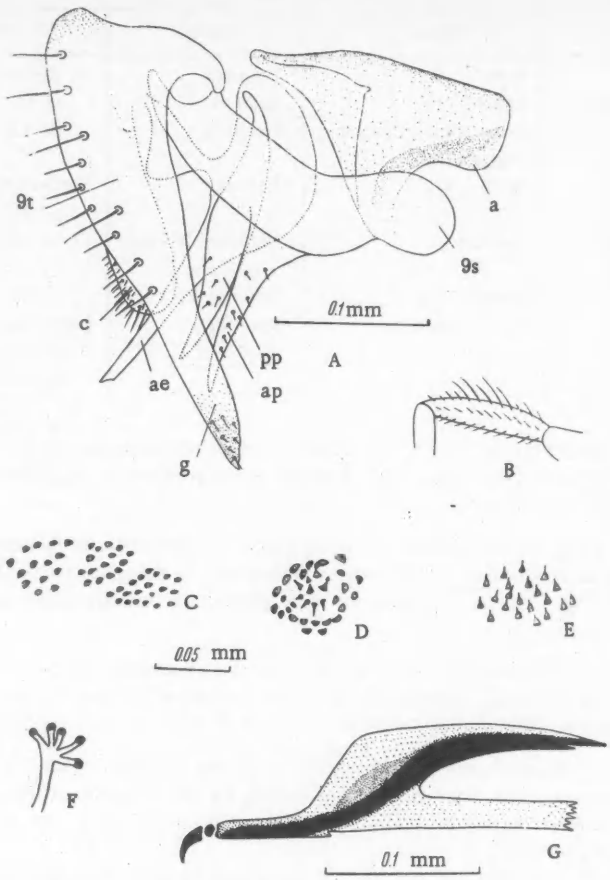

Fig. 6. Leucopis fumidilarva Tanasiichuk, sp. n.: A) male genitalia; B) femur of fore leg; C) cuticular outgrowths on dorsal side of 4th-11th segments of larva; D) locomotory tubercle of 6th-7th segments of larva; E) cuticular outgrowths of dorsal side of 3rd segment of larva; F) anterior spiracles of larva; G) mouthparts of larva.

2½-3 joints of tarsi of middle and hind legs yellow. On the inner side of the anterior femora are long hairs. Wing veins light brown, m and r_{4+5} slightly converge in the distal half. tr in relation to last portion of cu, 1 to 1.4. Halteres white. 2nd abdominal tergite almost completely covered by a large brown spot. On the 3rd tergite are 2 small, symmetrical, black spots. On each of the 4th and 5th tergites there may be a streak or spot, but they are often absent.

Male genitalia. (Fig. 6A). 9th tergite (9t) strongly contracted, the inwardly curving gonopophysis (g) sinuous and ending in a blunt tooth. 9th sternite (9s) massive, equally wide over almost its whole length.

Egg. Egg white, elongated oval. Surface ridges quite wide. Dimensions 0.48-0.50 x 0.18-0.20 mm.

Larva. Larva gradually tapers forward with the widely spaced trumpets of the posterior spiracles protruding sharply. The newly emerged larva is water-white in color. The larva which is feeding is greenish yellow with peculiar smoky marks. Along the middle of the back is a translucent, dark stripe. Posterior spiracles velvety black with light stigmata. Anterior spiracles bear 5 digitate processes (Fig. 6F), the posterior spiracles 3 apertures.

Encircling the anterior 3-4 segments are clearly marked rings of cuticular outgrowths in the form of

comparatively long apines. On the following segments these girdles are less pronounced. On the ventral side of each segment from 4th-10th are transverse ridges with 2 tubercles, the continuations of which appear as 2 tubercles on each side. On 2nd-3rd segments the ridges and tubercles are merely suggested. On the ventral side the cuticular outgrowths are represented by spines with wide, round bases. The transverse ridges and tubercles of the ventral side are set with sharp, almost pyramidal-shaped, spines surrounded by minute round processes (Fig. 6D). On the dorsal side the first 3-4 segments bear spines; on the following segments the spines are rounded and lose their points. Both spines and rounded processes are dark, almost black, and are evenly arranged in close groups on the back and sides (Fig. 6C), an arrangement which imparts to the larva a peculiar shagreened effect and smoky hue. The bases of the posterior spiracles are also studded with spines. Mouthparts as in Fig. 6G.

Length of newly emerged larva 0.7-0.8 mm, 2nd instar larva 1.5-2.7 mm, 3rd instar larva before pupation up to 3.5-3.8 mm long and 1-1.2 mm broad.

Puparium. Puparium barrel-shaped, reddish brown, preserving the chaetotaxy of the larva. Dimensions from 1.9 × 0.7 to 2.5 × 1 mm.

Biology. Eggs and larvae were observed July 14th, emergence of flies from puparia lasted until August 11th. Eggs are laid on Cirsium sp. and Melilotus sp. among colonies of Aphis medicaginis Koch. The development of the egg takes 2-3 days, and larvae develop in 5-6 days. Duration of pupal phase 13-14 days.

The species was collected only in Karadag.

Systematic features. Externally, the adult insect does not differ from L. glyphinivora subsp. taurica. The only difference is the presence of lengthened hairs on the front femora (Fig. 6B), but this feature is only one of degree. Nevertheless, the structure of the male genitalia is completely different, the larva also being sharply differentiated from the larva of L. glyphinivora. Besides that, L. fumidilarva is found only on Aphis medacaginis on which L. glyphinivora was never found.

Holotype: Male, July 2, 1957, Karadag.

In all collections a total of 10 specimens, males and females.

Leucopis rufithorax Tanas.

The species described was from the Leningrad district (Tanasiichuk, 1958). According to the structure of the male genitalia the Crimean populations are identical with the northern populations, but have a few differences with regard to the color of the dorsal side and legs:

Leningrad form	Crimean form
Mesonotum grey with reddish tinge to the posterior part. Lateral stripes much darker, brownish with a clear outline.	Posterior part of mesonotum of a more intense, golden red color. Lateral stripes of almost the same color, their outline in the posterior portion being diffuse.
Tips of femora and bases of tibia yellow.	Tip and base of fore legs yellow. Tibia of middle and hind legs yellow with dark tips.

Eggs, larval stages and puparia do not differ from those of individuals from the Leningrad District.

Biology. Eggs and larvae were observed July 26th. Late larvae were found September 27th-28th, at the same time as the last flies were observed on the wing. Eggs are laid on twigs and fruit of the Spanish broom among dense colonies of the aphid Aphis laburni Koch. The egg phase lasts 2-4 days. The larvae develop in about 5 days in July, at an average temperature of 23-24° and in 9 or more days in the second half of September when the numbers of aphids diminish and the average temperature drops on some days to 14°.

Fully grown larvae fall to the ground and bury themselves in the litter where they pupate. Among the summer generations the development of the puparium takes 13-14 days. The insect hibernates in litter in the pupal phase; there are not less than two generations which run one into the other. The Crimean form differs from the Leningrad form by the more condensed period of development — the whole cycle taking only 21-24 days (in the north — about 40 days).

In the Crimea it is known, up to now, only from Karadag.

A total of 34 specimens in collections, males and females.

Leucopis (Leucopomyia) silesiaca Egg.

Male, female. Length of body 2.5-3.2 mm. Body grey. Length of head compared with its breadth 1.5 to 1.7 to 1. Width of frons at level of ocelli compared with width of head 1 to 3 in male, 1 to 3.3 in female. Eyes oval. Frons light grey. Antennae and arista yellow, arista sometimes darker. 3rd joint of arista 4 times as long as 2nd. Length of gena $6\frac{1}{2}$-7 times less than length of eye. Palps and proboscis yellow. Lateral stripes on mesonotum (Fig. 7C) clear, dark brown, reaching as far as anterior dc. Median stripes weakly developed within the limits of the anterior fourth of mesonotum spaces between stripes, except the very front portion, furnished with bristles. There are 2 pairs of dorsocentral bristles and 1 pair of prescutal bristles. Femora black. Tips of femora, tibia and tarsi yellow. Wing veins light brown, m and r_{4+5} clearly converging in the distal half, tr relative to distal portion of cu, 1 to 1.3. Halteres yellowish. Abdomen with large brown spots on 2nd tergite, two round spots on 3rd and sometimes lines on the 3rd, 4th and 5th tergites.

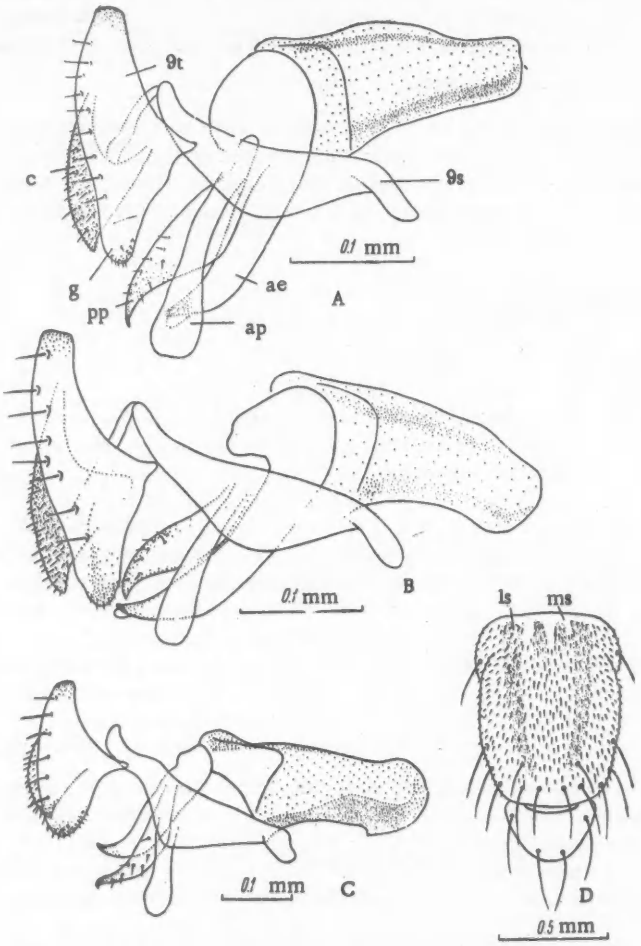

Fig. 7. A) Leucopis (Leucopomyia) alticeps Czerny, male genitalia; B) Leucopis bona Rohd., male genitalia; C) Leucopis (Leucopomyia) silesiaca Egg. Male genitalia; D) same, mesonotum.

Male genitalia. (Fig. 7C). 9th tergite (9t) wide and massive, narrowing toward the tip. Gonopophysis rounded. 9th sternite (9s) with curved posterior portion. Base of aedeagus (ae) no wider than its middle part.

Larva. 3rd instar larva, according to Rubtsov (1954), reaches a length of 3-3.5 mm. Body covered with cuticular outgrowths which one might fancy as being minute spines. They are blunter and thicker toward the posterior end. Anterior spiracles each have 3 stigmata.

Biology described on page 831.

Systematic features. The genitalia of the Crimean species is entirely identical with that of L. silesiaca (Hennig, 1938). Thanks to the curtesy of W. Schwenke we were able to compare the Crimean specimens with the mid-European which appeared to be somewhat darker, with antennae reddish brown instead of yellow.

It should be noted that, according to structural features (short gonopophysis with rounded end, strongly drawn-out apodeme, thin, semitransparent anterior parameres), the genitalia of Leucopis silesiaca and the nearly related Leucopis alticeps differ from the genitalia of the representative of the subgenus Leucopis s. str. which confirms the desirability of segregating them in a special subgenus.

In the Crimea the species is well known from Nikitsk Botanical Gardens and from Georgia.

There are 37 specimens in the collections of 1949-1951, males and females.

Leucopis (Leucopomyia) alticeps Czerny

Male, female. Length of body 2.0-3.0 mm. Body light grey. Length of head in relation to its width, 1.6 to 1. Width of frons at level of ocelli relative to width of head, 1 to 2.9 in the male, 1 to 3.2 in the female. Eyes oval. On the frons are two dark grey stripes passing around the ocelli. Base of antennae situated at the boundary of lower third of the head. Antennae black. 3rd joint of arista 2½ times longer than 2nd. Length of gena 5 times less than the length of the eye. Proboscis yellowish brown, palps black. Lateral stripes of mesonotum reddish brown and extend as far as anterior dc. Median stripes do not go beyond the anterior fourth of mesonotum. Spaces between stripes, as far as end of medial stripes, free from bristles. There are two pairs of dorsocentral and one pair of prescutal bristles.

Legs black. Tips of femora, bases and upper parts of tibia yellow. 1st and part of 2nd joint of tarsi of fore legs yellow, tarsi of middle and hind legs yellow with black tips. Wing veins light brown. m and r_{4+5} slightly convergent in the distal third. tr relative to distal portion of cu 1 to 1.2. Halteres the color of vegetable ivory. On the 2nd abdominal tergite there is a large brown spot. On the third tergite 2 symmetrical black spots. On the 4th and 5th tergites there is a small black spot which may be absent.

Male genitalia. (Fig. 7A). 9th tergite (9t) narrower than that of L. silesiaca. 9th sternite (9s) straight, only the extreme tip is curved. Basal portion of aedeagus (ae) very swollen.

Biology described on page 831.

Systematic features. The Crimean specimens agree entirely with the description of Leucopis (Leucopomyia) alticeps Czerny, differing only in the long, posterior, transverse vein (tr): in our specimens tr is a little shorter than the distal portion of cu, in those described by Czerny (1936) it is a little longer. Nevertheless, this difference is not of essential importance when considered with the rest of the features which are identical.

In the comparison of the material collected attention was called to the resemblance of the Crimean specimens with the cotypes Leucopis bona Rohd. from Central Asia. Very unimportant differences are seen in the much paler color of the lateral stripes and the frequent reduction of the medial stripes in the Central Asian individuals.

An examination of the genitalia supported the hypothesis concerning the identity of these species. The differences between the genitalia of L. alticeps (Fig. 7A) and that of L. bona (Fig. 7B) are very small: in the Central Asian specimens the anterior edge of the 9th sternite has a much smoother outline and the edge of the gonopophysis is sometimes a little sinuous. Nevertheless, among the Crimean collections specimens are met with in which the genitalia are indistinguishable from those of the Central Asian specimens. All this convinces us that Leucopis (Leucopomyia) alticeps Czerny. and Leucopis bona Rohd. appear to be one species for which the much earlier name must be abandoned.

The Crimean collections are from Nikitsk Botanical Gardens and Georgia; empty puparia were collected also in Simeiz and Alushta.

In the collections of 1949-1951 and 1957 there are about 130 specimens, males and females.

SUMMARY

The flies of the genus Leucopis from southern and eastern Crimea are described. Altogether nine species are recorded, three of which are new. Three groups of species are distinguished differing in their biology:

The First Group

The eggs are deposited in the colonies of different species of aphids living openly. The larvae crawl on twigs and leaves of the plant and feed on aphids. They pupate either on the plant or in the soil, and hibernate as puparia. The number of generations per year is never less than two. This group includes the following species:

Leucopis argenticollis Zett. (Fig. 3).

Leucopis melanopus Tanasiitshuk, sp. n. (Fig. 4).

Leucopis glyphinivora taurica Tanasiitshuk, subsp. n. (Fig. 5).

Leucopis fumidilarva Tanasiitshuk, sp. n. (Fig. 6).

Leucopis rufithorax Tanas.

The Second Group

The eggs are deposited inside the aphid gall. Both the feeding of the larvae on aphids and the pupation take place inside the galls. Nothing is known so far about the hibernation and the number of generations per year.

This group is represented by Leucopis palumbi Rd. (Fig. 2).

The third group.

The eggs are deposited in the ovisacs of Filippia viburni Sign. and Pulvinaria pistaciae Bod.

The larvae develop and pupate in the ovisacs. There are two generations per year. There are as yet no observations concerning the hibernation. The representatives of this group are Leucopis (Leucopomyia) silesiaca Egg. and Leucopis (Leucopomyia) alticeps Czerny = L. bona Rohd., syn. nov. (Fig. 7). Besides these species one new species Leucopis grandis Tanasiitshuk, sp. n. (Fig. 1) is described, the biology of which as yet has not been studied.

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REVIEWS AND BIBLIOGRAPHY

Vladimir J. A. Novak. Insektenhormone, CS. Akad. Ved, Prag, 1959: 1-283. (Vladimir Novak. Insect Hormones. Published by the Czechoslovakian Academy of Sciences, Prague).

In recent years the study of insect hormones has formed one of the most intensively developed fields of inquiry in general entomology. The whole history of this study has taken, in all, a little more than 25 years, so that although the older works of Kopets (1922-1924) and Buddenbrock (1930, 1931) included a few remarks about the hormone nature of metamorphosis and molting, unquestionable evidence for the existence of hormones was, for the first time, given simultaneously by Bodenstein (1933) and Uiglisuors (1933). At that time an enormous number of researches were being conducted on the topography, morphology and cytology of the endocrine glands, on elucidating the significant actions of hormones in the processes of molting, metamorphosis, diapause and sexual maturation, on the chemical structure of hormones and the mechanism of their action, and on their interactions and their physiological influence on metabolism. A series of combined reviews are already published as well as special chapters in various types of books and textbooks.

The book by V. Novak differs from previous reviews, first and foremost, by its exhaustive nature. Besides that, it includes the literature up to 1958, at a time when other reviews, as in every rapidly developing branch of knowledge, were somewhat out of date; the literature cited (1512 titles) include many Soviet researches directly connected with the problem. Moreover, Novak's book is not simply a dull review, but a creative, well-treated summary which reflects the original opinions of the author on the importance of hormones and the mechanisms of their actions. The book presents, in an excellent manner, the up-to-date standard of learning on the nature of a new branch of entomology — insect endocrinology.

The book consists of 10 chapters. Following a short introduction, the methods and techniques of hormone research are closely examined. This chapter is a very useful one, since it introduces the reader to the details of various technical, microscopical operations on insects and deals, in a general way, with the most up-to-date research work in insect tissue culture and on the treatment of thick cuticle for histological purposes, etc.

In the third chapter the fundamental causes of metamorphosis are discussed. This chapter appears to be the main one since it occupies over 100 pages of text; it is divided into 4 sections; (1) hormone activation, (2) hormonal molting or ecdysis, (3) juvenile hormone or neotinine, (4) the nature of metamorphosis.

The substances produced by the neurosecretory cells of the brain is called by the author, hormone activator: in this section are considered the processes leading to its formation, its accumulation and transformation in the corpora cardiaca, the ways in which it influences the secretory glands and, thereby, the various processes in morphogeny and metabolism, and also the converse influence — retardation of neurosecretory activity. The author examines hormone activator both in the arthropods which are the oldest in phylogeny, in so far as neurosecretory cells are distinctive, and in annelids and other groups of invertebrates.

The morphology of the prothoracic glands and of the ventral glands, their probable serial homologs in the orthopteran insects, is given in the second part. At the same time the author writes in favor of the true homology of the two developments, assuming that the ventral glands arise in the prothoracic segment and only secondarily become fused with the segment of the second maxilla.

The question of the function of the prothoracic gland hormone — ecdysin — is discussed at length. The author emphasizes that this hormone determines only the phenomena of molting, that is, the process leading to the discarding of the cuticle. The idea that ecdysin is a hormone of growth or differentiation is not proved

experimentally; ecdysin controls morphogenesis — growth and development — only indirectly, insofar as both these processes are connected with molting.

It is surprising that Novak follows certain authors (E. Thomsen, 1946; M. Thomsen, 1951) in thinking that the pericardial glands (Pflugfelder, 1938), discovered in Phasmoidea, are homologous with the peritracheal glands of the higher diptera, referring to Possompes as if he was corroborating that point of view. As a matter of fact, this author (Possompes, 1953) pointed out the inaccuracy of this homology inasmuch as the peritracheal glands are of ectodermal origin while the pericardial glands of the Phasmoidea are mesodermal in origin; he considered the peritracheal glands of the fly, which enter into the formation of the so-called Weismann's ring, as homologous with the prothoracic glands of other Holometabola. Such a treatment is considerably better if linked with the function of the peritracheal glands following experiments by a number of authors (Hadorn, 1937; Vogt, 1947; Possompes, 1953, and others). The function of the pericardial glands of the Phasmoidea remains unexplained.

In the third part of the chapter the structure of the corpora allata is examined, also its embryology and the significance of the hormone secreted by them — neotinine — on morphogenesis and metabolism.

The author draws attention to the fact that the hormone of the corpora allata, while determinine the onset of histolysis, influences the process of molting only indirectly. In addition to this it is debatable whether one should consider the absence of the gonad-stimulating function of the corpora allata in Bombyx and Phasmoidea as some secondary adaptation.

In a skillful discussion of the various theories concerning the mechanism of the activity of the corpora allata (Wigglesworth, Piepho, Bodenstein, Pflugfelder, L'Helias), the author brings out their imperfections and contradictions and then goes on to the general problem of metamorphosis in the fourth section of the chapter.

After critically examining the opinions of Berleze,-Ezhikov, Zakhvatkin, Gilyarov and Uiglsuors the author carefully substantiates his gradient-factor theory, first put forward by him in 1951. Novak considers that in every normally developing organism there is inherent some developmental factor, which he calls "gradient-factor," determining the natural correlation between the processes of growth and differentiation in various parts of the embryo and, consequently, determining the diversity of forms in the process of morphogenesis. Among Tracheata the significance of this factor in a pure form is revealed only in Myriapoda and Apterygota in which the corpora allata are absent. In all true insects its action is temporarily suppressed as a consequence of its inactivation by the hormone of the corpora allata and is retained in Hemimetabola only in isolated regions or in Holometabola in the imaginal disks. Thus, the larval tissues undergo a unilateral growth; the imaginal tissues slowly grow and develop quickly only when the secretory activity of the larval (nymphal) corpora allata ceases.

The principal reason why Novak's theory did not find sufficient recognition in world literature was because, as we have shown, the gradient-factor is a fallacious postulate. It is scarcely possible to think that a "developmental substance" exists which determines all the variety in morphogenesis. Genetical analysis under studied conditions shows that the various processes of growth and differentiation in different embryos are determined entirely by the various hereditary factors operating enzymatically. Apparently, Novak refers his gradient-factor to some such similar kind of substance (Desmohormone) but the hypothesis about its uniqueness and the universality of its activity remains unconvincing. On the other hand, the action of neotinine in inactivating this hypothetical substance also appears to be a working hypothesis since, without an experimental basis, the author attempts to give a biochemical treatment to an old and well-known fact of inhibiting activity which the hormone of the corpora allata exerts on metamorphosis. No wonder that neotinine was up to recent times called hormone inhibitor. Lastly, Novak's theory, in spite of the author's endeavors to show the reverse, does not permit the many inconsistencies which have, at the present time, appeared among various authors in the determination of the interactions of the various hormones, for example: The theory is not able to explain why supplementary molting in the cockroach is achieved by transplantation of the prothoracic glands together with the corpora cardiac (Bodenstein), while in the Phasmoidea the same effect is attained by the transplantation of the corpora allata (Pflugfelder); many other examples can be given. Thus, Novak's theory with all its aptness cannot be considered as sufficiently established, so long as it is not clear what new prospects it reveals for experimental research.

In the fourth chapter hormonal factors in the diapause of insects are analyzed. First of all the author briefly discusses the nature of diapause and the role of the various ecological factors in its origin. The works of Williams and his collaborators on the pupal diapause of Platysamia cecropia are considered in great detail, also the works of the Japanese research workers on the hormone factors regulating the embryonic diapause of the eggs

of the succeeding generations of the mulberry silkworm. As in other chapters, Novak gives special attention to the historical setting of the phenomenon of diapause, allotting a special section to the hypothetical course pursued in the phylogeny of diapause. In this connection it is just as well to observe that diapause undoubtedly originated several times, in a convergent manner, in various orders of insects (and not only insects); therefore, the ecologicophysiological steps in the historical account given by the author scarcely reflect the actual paths of its origin in the separate species.

In the small fifth chapter the author discusses the special cases of neurohormones — the change in the forms of melanophores in the larvae of Corethra and in the Phasmoidea, and also other examples of variability of color connected with humoral, activating factors.

The sixth chapter is loosely devoted to the study of the question of hormone regulation in the sexual cycle of insects and the hormone activity of oenocytes; the seventh briefly gives the characteristics of biohormones which regulate eye color; the eight deals with exohormones influencing the relationships in the families of social insects.

Briefly, but in a thoroughgoing manner and including the most recent researches, all these chapters throw light on the diversity of hormone regulation and give a good introduction to the many debatable and still unstudied questions on the contemporary endocrinology of insects.

In the ninth chapter the very involved question of the correlation between the hormones of insects and those of vertebrates is discussed. While pausing on experiments dealing with the influence of insect hormones on other groups of animals and on attempts to demonstrate the effects of various vertebrate hormones on insect development, the author rightly concludes that there are no experiments which demonstrate a definite influence of the hormones of one type of animal on animals of the other type; positive results obtained by individual authors are not sufficiently conclusive or they bear an obviously nonspecific character.

In the concluding tenth chapter the author stops to consider the theoretical and practical importance of insect hormones. He gives some interesting ideas on the origin of the hormones of the endocrine glands beginning with the prehormonal stage in which intracellular hormones were secreted by all the cells of the organism, a prohormonal stage in which there was a secretion of excess of these hormones into the hemolymph, a stage in the weaving together of hormones, and two phases entailing the gradual physiological complication in the activity of endocrine glands. The question of the importance of the study of hormones on the general problems of insect phylogeny is treated in a separate section in which the author associates himself with Cazal's opinion that contemporary data on insect hormones and the endocrine glands are surprisingly in accordance with the general systematics of the subclasses among winged insects worked out by A. V. Martynov on morphological foundations.

In the last chapter the author briefly considers the practical importance of research on insect hormones, in particular its connection with the toxicity of insecticides.

The publication of Novak's book appears to be an outstanding event in the world literature on entomology.

The collossal amount of experimental material collected together and elaborately referenced shows the author to be a highly erudite and imaginative investigator, creative in dealing with one of the most important sections of insect physiology.

D. M. Shteinberg

ERRATA

Correction to the Article by G. Ya. Bei-Bienko "Dermaptera of Szuch'uan and Yunnan" (Ēntom. Obozr. XXXVIII, 3: 590-627; English translation, pp. 529-563)

The generic name Protolabis B.-Bienko (p. 597)* has previously been used twice in Mammalia (Protolabis Cope, 1876, Proc. Acad. nat. Sc. Philan. 1876: 145; Wortman, 1898, Bull. Amer. Mus. nat. Hist. 10:120) and, therefore, must be replaced by the name Prolabisca B.-Bienko, nom. n. The corresponding name of the subfamily is changed to Prolabiscinae B.-Bienko, nom. n.

* English page 539.

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